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Supply flexibility and risk preferences experiment for a microchip company

Master Thesis

Author: Diana María Zahera García

Spring Semester 2015

Supervisor - Wang He-Xin

"Before anything else, preparation is the key of success"

Alexander Graham Bell

To my father, for his engineering passion.

Abstract

In this thesis we will focus our analysis in the inventory decisions with one specific kind of sourcing contract. More concretely, we will study and analyze the order quantities under a supply flexible contract conditions.

The quantity flexibility contract in supply chain management is committed to reduce the risk of both retailers and suppliers, and optimize the profit of the whole supply chain at the same time. Under this contract, retailers are allowed to correct the base order quantity with an extra quantity order. This fact will benefit the retailer to suit the demand uncertainty.

By experimental research, the thesis focuses on the limited-rational decision making of the human behavior in the operations management. The experiment is designed from the perspective of the retailer. Retailers make corresponding security quantity order decisions according to variable demand environment information. The thesis has established a mathematical model, which can derive the theoretical optimal values for the amount of extra quantity order. According to the statistical analysis of the actual quantity order, the study focuses on the differences between the actual decision and the theoretical optimum, and explains the reasons for deviation.

The experiment set up four control groups to study the factors' influence on retailers' actual security quantity decisions by changing the reservation deposit and the product's high or low profit margin level. The results show that the retailers are rational limited in the decision making. Their decisions are influenced by many factors, causing the ordering deviation.

Through the comparison and analysis, the thesis attempts to provide a reference for retailers' actual ordering decision, and lead to optimal largest possibly and ultimately achieve the best practices in order to try to resemble their real results with the theoretical optimum. At the same time, it's necessary to reflect the deficiency of the research which can provide a new direction for the further theoretical research.

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1 Introduction

Nowadays companies must function in a challenging business environment with extensive uncertainties and variations. To operate in this conditions, enterprises must be able to anticipate market swings and have the ability to react to adjust costs and make effective responses.

The key to do this is planning an effective management strategy in the supply chain between the buyers and suppliers in order to accommodate the uncertainties and variations in each other's businesses.

In this situation, the importance of having a robust relationship between the retailer and the supplier under changing supply conditions becomes crucial. It's essential to know the different types of supply chain contracts and arrange the most appropriate for both. This robustness relationship can be defined as the supply chain flexibility, which is the parameter for characterizing the behavior of variable supply chains. Supply chain management presents an especially important domain where such flexibility is critical to achieving a consistently successful performance.

In this thesis we introduce an experiment of the supply flexibility estimation and the risk preferences in the decisions taken. Using a mathematical model we can estimate the supply flexibility and hence make a quantifiable choice. For this kind of arrangement, the type of contract that we will work with is the "Quantity flexible supply chain contract".

Some studies confirm that the order quantities are the most common variable parameter in the supply chain, and it can cause supplier-retailer grievance. So we are going to work in this field in order to find out the weaknesses of the process and analyze them in order to make efficient improvements in the decision makings.

2 Problem statement

The complexity level in the company's operations management is in growing exponentially. The markets are increasingly competitive, and the cost reduction and the optimization are key elements in a world where the maximum profit is the ultimate goal.

The supply Chain management is the tool in order to solve the problems between suppliers and customers, which require effective, efficient and mutually beneficial processes. The use of the best practices and the continuous adaptation to the market swings through a planning strategy are the ingredients to get the maximum supply satisfaction for all the chain stakeholders.

The random market demands are hard to control and requires an extensive monitoring and rapid decision taking to get the desired outcomes.

The lack of flexibility in the supply processes makes a worst adaptability to markets and demands requirements. We can consider that nowadays the flexibility in the key piece in the puzzle of the supply chain.

In this thesis, we will design a one-period with two-stage (Figure 3) quantity flexibility supply contract between a buyer and a supplier. The concept of the problem revolves around the idea that the buyer has an option in the second stage to increase his first-stage order to a largest amount of the initial purchase.

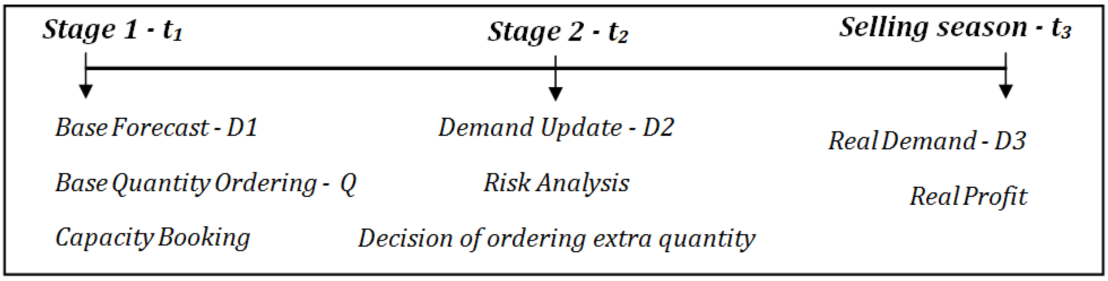


Figure 1 - Problem period

Therefore, we can find some problems in the management of the supply period that is going to be analyzed. The adjustment of the ordering quantity adds difficulty to the situation management. It is important to have a robust forecast in order to reduce the risk taken with the decisions.

The calculation of the extra quantity must be very accurate, as it is the key issue because it directly affects the final profit. If we adopt a risky position and we ask for a large quantity, it can generate a surplus in our inventory that require a storage cost and do not give us any profit. If instead, we decide in a more conservative way and do not ask the amount sufficient (or do not ask for any extra quantity) maybe the demand will not be fully satisfied and we can lose revenue.

Finding the balance in this situation is complex. We will try to study what the optimal decision problem would be, using mathematical models which have been investigated adapting them to our specific case.

That done, we will experiment a set of simulations of a sample of individuals in order to compare their results with each other and with the optimum solution. In this way, we will be able to analyze the risk behavior in their decision making.

Therefore, our main goal will be to find a positive relationship between the flexibility and the company's profit.

3 Theory - The Supply Chain definition

The company's survival in a growing harsh environment no longer depends in improving their operations and integrating their internal functions. But is necessary to go beyond the borders of the company and initiate information exchange, materials and resources relationships in a more integrated way, using innovative approaches such as Supply Chain Management which benefit all the chain stakeholders.

The supply chain is a subsystem within the organizational system that includes planning activities involved in manufacturing, processing, distributing and obtaining products. It permits the best practices implementation in frameworks as the supply and demand planning, production, transport, warehousing, purchase and customer service.

For most companies, even if they are industrial, commercial or of services, the Supply Chain is the key of developing the businesses and it conforms the network between the prior stages and the rear ones.

The functions which are involved in the Supply Chain are always intended to the reception and the satisfy of a customer's request. This functions include also new product development, marketing, operations, distribution, finance and customer service.

3.1 The concepts

There are three concepts to have in mind about the Supply Chain general framework:

✓ The Supply Chain, encompasses business processes, people, organization, technology and physical infrastructure that allows the transformation of raw materials and intermediate products and finished services that are offered and distributed in order to satisfy consumer demand.

✓ The Value Chain, consists of a series of processes that allows a company to handle their products from conception to commercialization so that value is added at each stage.

✓ Supply Chain Management (SCM) is the planning, organizing and controlling of the supply chain activities. In these activities it is involved the management of cash flows and product or service information, throughout the supply chain in order to maximize the value of the product/service delivered to the final customer while decreasing the organization costs.

3.2 The phases

The Supply Chain has three different phases:

1. *Supply:* it involves the way how, where and when the raw materials can be obtained and proportionate for the manufacturing of products.

2. *Manufacturing:* phase in which the raw materials are transformed in the final product.

3. *Distribution:* it ensures the final product receiving to the customers through a distribution network, warehouses and points of sale.

Therefore, the Supply Chain is the sequence of suppliers and customers which contribute in the creation and delivery of a product or service to a final customer. Find attached in the next figure the Supply Chain network with the information and cash flows in each stage of the chain.

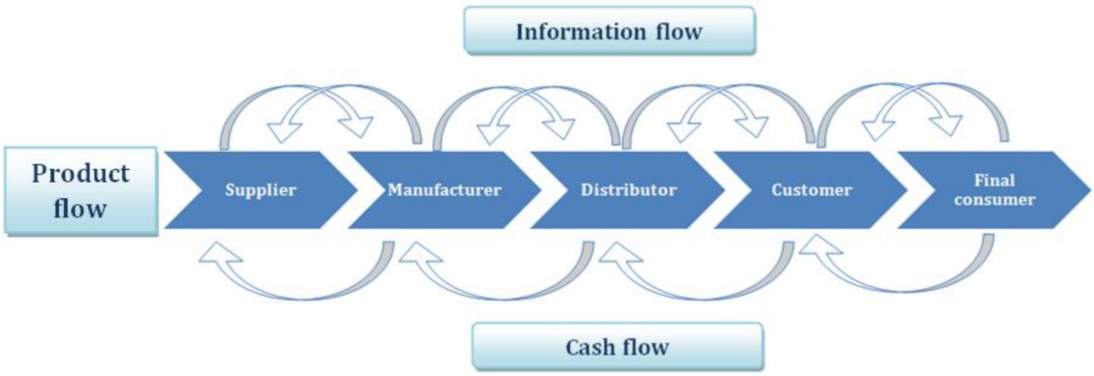


Figure 2- The Supply Chain Flow Process

As we can see at the Figure 1, every stage of the chain is connected through a flow of products, information and cash. It's main characteristic is it's dynamism and it needs a constant flow to work.

In this thesis we will focus our study in the distributor chain stage, we can call it the retailer, our supplier will be the manufacturer and the products we are going to work with are microchips.

This means that our case consists in buying a final product to the manufacturer and selling it to our customers. At this stage, we will work and experiment in 3 important dimensions of the SCM: information technology, organization structure and strategy and human factors.

Each of this dimensions are crucial, but by their selves they do not provide a complete overview of the Supply Chain and its management. The three dimensions combination result in the generic supply chain model on which they all provide a related conjoint contribution. See in the Figure 2 these three dimensions and its relationships:

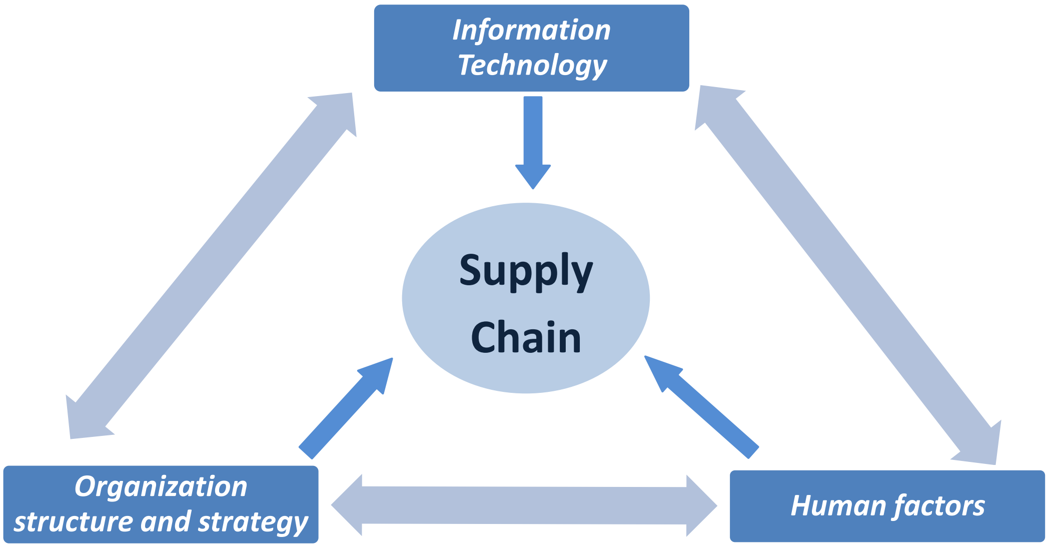


Figure 3 - The Supply Chain Management

3.3 Decision levels

The resolution of Supply Chain problems implicate strategic, tactic and operational levels in the activities done. Some of the key points for troubleshooting are the following:

- ✓ Sourcing contracts and purchase decisions.
- ✓ Production decisions and Planning definition.
- ✓ Inventory decisions, which involve the quantity order, localization and quality of the inventory.
- ✓ Transport strategy which complete the frequencies and routes.
- ✓ Benchmarking of the operations against competitors and best practices implementation.

The decisions that must be taken in a problem resolution way, can be classified in different levels:

1. Supply Chain design

At this level, the company decides how to structure its own Supply Chain. Making the design needs the planning of the way of the resources and processes distribution having in mind the uncertainty in the conditions.

It is needed a prioritization of taking long term decisions because of the extra cost of modify short term ones.

2. Supply Chain planning

Knowing that the Supply chain configuration is fixed, the decisions of a period must be analyzed. After, the restrictions of the system must be configured for structuring the planning system. The goal always is maximize the profit maintaining the restrictions already configured.

This level includes the analysis of which markets are supplied, and from which locations. Also includes the decisions of subcontracting production, the inventory policies that are going to be taken and the opportunities and magnitude of marketing and price promos.

3. Supply Chain operations

This level involves a short term decision making. The diary or weekly reactions about the customer's requests. The goal of this level is to manage the orderings as better as possible fulfilling the system requirements previously set. The decisions at this level include the inventory distribution, the production planning, the lead times, assortment of store lists, transport planning etc.

4 Introduction to the Supply Chain contracts

Nowadays there are so many kinds of companies and businesses which have different needs of Supply Chain Management (SCM) and control. It is a key element for the enterprises competitiveness because it's directly related to the business results, the profit margin, the lead-times, the product/service quality and the customer's satisfaction.

The objectives alignment between retailers and suppliers is essential in order to have the most efficient supply chain, and therefore the better performance possible and the maximum profit for both.

It is in that point where the negotiation between the buyer and the supplier is involved and the conditions of the contract must be thoroughly worked and detailed.

With the current studies of Supply Chain Management (SCM), several kind of contracts have been defined and detailed that can be the base in the negotiation.

The main strategic components of the contracts are the following:

- Pricing and volume discounts.
- Minimum and maximum purchase quantities.
- Delivery lead times.
- Product or material quality.
- Product return policies.

4.1 Main types of Supply Chain contracts

1. Buyback contract

This kind of contract allows the buyer to return unsold inventory up to a specified amount at an agreed upon price. Therefore, we can find that the optimal order quantity for the customer increases. This increase result in a higher product availability and higher profits for both buyer and supplier.

It gives most effectiveness for products with low variable cost, such as music, software, books or newspapers. But it also can increase the supply chain costs because the buyback contract results in surplus inventory for the supplier that must be disposed of.

We cannot forget that this kind of arrangement can be misleading for the supply chain as it reacts to (inflated) retail orders, not real customer demand.

2. Quantity discount contract

Under quantity discount contract, the buyer must pay a wholesale price depending on the order quantity. This resembles to the sales rebate contract, but there is no threshold defined. The mechanism for specifying the contract can be complex. The contract has been applied in many situations, for example, in an international supply chain with fluctuating exchange rates.

3. Quantity flexibility contract

Allows the buyer to modify the order (within limits) as demand visibility increases closer to the point of sale. Better matching of supply and demand Increased overall supply chain profits if the supplier has flexible capacity Lower levels of misleading demand information than either buyback contracts or revenue sharing contracts

4. Option contract

This kind of contract makes the buyer pre-pays a relatively small fraction of the product price up-front. In this situation, the supplier commits to reserve capacity up to a certain level. This initial payment is called the reservation price or premium. After, if buyer does not exercise option, the initial payment is lost.

The buyer can purchase any amount of supply up to the option level by:

a) Paying an additional price (*execution price* or *exercise price)* agreed to at the time the contract is signed

c) Total price (reservation plus execution price) typically higher than the unit price in a long-term contract.

5. Sales rebate contract

Provides a direct incentive to the buyer to increase sales by means of a rebate paid by the supplier for any item sold above a certain quantity. Basically, this contract specifies two prices and a quantity threshold. If the order size is below the threshold, the buyer must pay the higher price, and if it is above, he can pay a lower price for the units above the threshold.

6. Revenue sharing contract

In this contract, the buyer pays a minimal amount for each unit purchased from the supplier but shares a percentage of the revenue for each unit sold. This makes decrease the cost per unit charged to the buyer, which effectively decreases the cost of overstocking.

This kind of contract is misleading for the supply chain as it reacts to (inflated) retail orders, not actual customer demand.

5 Quantity flexibility contract

The flexibility of the Supply Chain is determined by the capacity of response in terms of volume and variety in front of the changes of consumer behavior.

Quantity Flexibility Contract has been used in many industries (automotives, computers, apparel etc.) as a tool to minimize the impact of demand uncertainty and develop trust between supply chain actors. This contracts allow the retailer to modify his order, within a predefined range, to the supplier after better forecasts updating of the customer demand become available. On the other hand, the supplier benefits from more accurate order forecasts that result into smoother production schedule and less overage and underage costs.

There are so many kinds of quantity flexible contracts, depending on the sector of the enterprises, the parts of the Supply Chain involved and the conditions arranged between them.

This study will evaluate a specific kind of quantity flexible contract, between a retailer which buys microchips to sell them to its customers and a supplier who manufactures them.

In the electronic market, we have the advantage that the microchips are not perishable, so the risk in the supply chain operations is reduced because the complexity in lead times and storage is easier.

Our retailer will ask for a fixed base quantity in order to cover its usual demand, and it will pay a security cost in order that the supplier reserve a certain production capacity for possible demand peaks.

This security cost is fix, but the decision of purchasing the extra quantity or not is after, when the demand is already known. This situation is beneficial for the retailer, as it is always guaranteed to cover its demand. Also can be beneficial for the supplier in the cases that the retailer finally reject the extra quantity order, because the fix cost is already paid.

The amount of the reservation and the fixed cost for it can be adapted to their specific situation, in order not to take advantage one to the other. The goal of this contract is to try to apply flexibility in the quantity ordered in order to maximize both profits and covering all the demand requested.

6 Literature review

The Supply Chain management is an emergent discipline, and therefore it possesses the characteristics of a continuous development theory and applications. The lack of clarity in certain concepts or the weak overlap between the different areas which form the SCM lead to result a body of knowledge that is still in construction.

Now we are at a time of literature explosion that is trying to fill the numerous gaps and uncertainties living with SCM. That is why some of the information that is handled as certain becomes obsolete.

The literature devoted to aspects of the chain such as logistics, purchasing, operations management, etc. is plentiful. (Rungtusanatham et al., 2003; Croom et al., 2000; Carter & Ellram, 2003).

In the particular case of the Supply Chain contracts what we can find in literature are concrete applications of each kind of contract in a determined environment, that cannot be extrapolated to the generality, but it can works as a data base or for general theories checking test.

Over the last decade the supply chain management has become in a prominent research area. (Mentzer et al.,2001). Nevertheless, there are still clear opportunities of growth and improvement in the SCM research. The professionals criticize the researchers for the lack of focus in the real causes of the daily management dynamics and they encourage them in spend more effort in the challenges faced by the SC managers every day. (Tushman & O'Reily, 2007; Markides, 2007; Gulati, 2007; McGahan, 2007).

Supply Flexibility contracts

We can find Tsay & Lovejoy (1999) which publish their study about the importance of flexible quantity contracts under a rolling planning horizon. They discuss some fundamental aspects about such contracts, as the limits and thresholds which determine the minimum or maximum quantities to order in each revision, and the damping of bullwhip effect that provide this type of contract.

Tsay (1999) extends the previous study and characterizes the implications in the behavior and the performance of the chain steps. Wu (2005) studies it under the Bayesian update of demand information and Sethi et al. (2004) under the demand updating in each period. Wang et al. (2006) analyze it under an inflexible production environment. Lian & Deshmukh (2009) develop a dynamic model of finite horizon in order to characterize the buyer's optimal sourcing strategy.

It is very common in the Supply Chain Management that its different participants don't work together for maximize the global revenue of the chain, but make decisions based on strict maximizing their own profit. This results in a system efficiency loss supported by the local incentives provided, which contradict the objective in the global system. One possible answer for this problem is to reconsider the Supply Chain contracts nature and the redefinition of them.

Some flexible risk-sharing contracts have been analyzed in more realistic conditions by Bassok & Anupindi (1995). Eppen & Iyer (1997) analyze the security agreements in which the buyer is allowed to buy a certain security quantity in excess of its initial forecast without any extra cost, but with the penalty for the units not purchased. Kamrad & Siddique (2004) analyze why a buyer and a supplier must accept a flexible contract, in terms of their own revenue.

Finally, Sethi &Yan & Zhang (2004) analyze the model of quantity flexible contract with information updates in the demand. Their study is based in a buyer's who is allowed to order an additional quantity with an extra cost which is specified at the contract. This theoretical model can be adapted to the particular case that we are going to develop in this thesis. The hypotheses will be extrapolated to our specific problem and the mathematical model will be simplified to the study environment.

7 Risk management and Supply Chain flexibility

Uncertainties in the operating environment of firms reduce the reliability in terms of delivering at the right time, at the right amount and quality. Uncertainty requires firms to quickly respond to changing environments. Operating in a flexible supply chain helps the firms to accomplish this rapid adaptation. On the other hand, increasing flexibility brings along additional risks for the firms to undertake. Alignment, adaptability and agility (flexibility) are fundamental elements for supply chain risk management.

It is accepted that flexibility increases Supply Chain resilience. However, firms are reluctant to invest in flexibility when it is not clear how much flexibility is required. The higher the flexibility, the riskier is the chain. However, there are some methods and models which help to mitigate the level of risk associated with the level of flexibility.

This section analyses the relationship between supply chain flexibility and supply network risk management.

7.1 Risk sharing

In the sequential supply chain:

- ✓ Buyer assumes all of the risk of having more inventory than sales.
- ✓ Buyer limits his order quantity because of the huge financial risk.
- ✓ Supplier takes no risk.
- ✓ Supplier would like the buyer to order as much as possible.
- ✓ Since the buyer limits his order quantity, there is a significant increase in the likelihood of out of stock.

If the supplier shares some of the risk with the retailer:

- ✓ It may be profitable for buyer to order more .
- ✓ Reducing out of stock probability.
- ✓ Increasing profit for both the supplier and the retailer.
- ✓ Supply contracts enable this risk sharing .

7.2 Risk behavior evaluation factors

In this chapter we will define the way to evaluate the risk factors in the experiment we will explain forward.

In order to determine daily risk behaviors in a subjects set is to make a survey with key questions. The sincere results will help us to determine the risk level of each subject in a mathematical format.

There are so many studies about the factors of the personal behavior and how to quantify the risk taken in daily situations.

Firstly, we will define a vector called:

$$U = \{u_1, u_2, u_3, u_4, u_5, u_6, u_7, u_8, u_9, u_{10}\}.$$

Each vector component corresponds to a survey question which reveals the risk taking from a subject. In the Chapter 10 it is exposed the final survey questions and it will be explained which 10 have been choice to risk evaluation.

After making the survey, it is must to codify the answers into numbers in order to work with them. It is also required to use a specific code that permits to see that the most risky situations are the bigger numbers. therefore, the order of the answers must be specific (from safety to risky for example) in order to make the codification easier.

From now, when we have already the answers encoded, it is needed to calculate another vector with the common factor variance of each question:

$$A = \{a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8 a_9, a_{10}\}$$

Being:

$$a_i = \frac{H_i^2}{\sum H_i^2}$$

This vector will mark the weigh or the importance of each of the survey questions, as it depends on the variance in the answers.

The objective is to get a final vector which reveals how risky a tester is. This vector is called:

$$V = \{V_1, V_2, V_3, V_4, V_5\}$$

Where the position of the maximum number of the vector corresponds to the risk level of the subject.

V1	*V2*	*V3*	*V4*	*V5*
High Risk	Medium Risk	Risk	Safe	High Safe

In order to get this vector, we need to define a evaluating matrix for every tester with a new code depending on their answers. This matrix is called R_j being $j = 0, \dots, n$ testers. The matrix dimensions are $i\ x\ 5$ in order to adapt the number of questions $i = 1, \dots 10$ with the 5 risk levels.

The main characteristic of this matrix is it's encode in which it is created. This encode classify each answer with its risk level as it is explained in the following table:

Assuming that the answers are sequenced from low risk to high risk:

A<B<C<D<E

Answer	Encode				
A	0	0	0	0.2	0.8
B	0	0	0.2	0.3	0.5
C	0	0.2	0.3	0.3	0.2
D	0.5	0.3	0.2	0	0
E	0.8	0.2	0	0	0

So, from this, we can create the evaluating matrix of each subject for all their answers, as we can see in the next example:

Questions	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Answers	A	B	C	D	E	A	B	C	D

Therefore, the evaluating matrix will be:

$$R_1 = \begin{bmatrix} 0 & 0 & 0 & 0.2 & 0.8 \\ 0 & 0 & 0.2 & 0.3 & 0.5 \\ 0 & 0.2 & 0.3 & 0.3 & 0.2 \\ 0.5 & 0.3 & 0.2 & 0 & 0 \\ 0.8 & 0.2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.2 & 0.8 \\ 0 & 0 & 0.2 & 0.3 & 0.5 \\ 0 & 0.2 & 0.3 & 0.3 & 0.2 \\ 0.5 & 0.3 & 0.2 & 0 & 0 \\ 0.8 & 0.2 & 0 & 0 & 0 \end{bmatrix}$$

Finally, when the vector A is defined and the evaluating matrix of each subject is already calculated, we can find the vector V with the following expression:

$$V_j = A \times R_j$$

$$\{V_1, V_2, V_3, V_4, V_5\}_j = \{a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8 a_9, a_{10}\} \times R_j$$

The results of the experiment are exposed in the chapter 10 of this thesis.

8 The general mathematical model for flexible quantity

In this section we will design a quantity flexible contract between our supplier and us (the buyers). In this kind of contract, we have the option in a second stage to make an extra quantity order which can increase our initial purchase. The specifications of the contract are the following.

We will refer to stage 1 as t_1 and to stage 2 as t_2.

(1) D = Demand distribution is uniform U(0,100). [un]

(2) Q = The base quantity order at t_1. [un]

(3) q_a= Additional quantity that can be ordered at t_2. [un]

(4) c = Fix cost for ordering. We can consider that each order have the same ordering cost. If we need to order the extra quantity it will take another ordering cost.

(5) p = cost for buying the products to the supplier. [m.u./un]

(6) m = Security deposit for booking capacity of the supplier for ensuring the supply of the extra quantity q_a.

(7) r = Selling price for the revenue. [m.u./un]

(8) s = Storage cost for unsold quantity $s < p$[m.u./un]

(9) $I = 1 \; or \; I = 2$ Binary variable which becomes 2 if the decision of ordering an extra quantity it's taken. $I = 2 \;\; if \;\; q_a > 0$

Thus, we can define the buyer's optimal profit π^*

$$\pi^* = max_{Q\geq 0}\{E\big(\Pi(Q, q_a, I)\big)\}$$

where

$$\Pi(Q, q_a, I) = E[r \cdot min(D, Q + q_a) - s \cdot max(0, Q + q_a - D) - p \cdot (Q + q_a) - m - c \cdot I]$$

The term $p \cdot Q$ represents the purchase cost of buying at a price p an amount Q at t_1. Similarly, the term $q_a \cdot p$ is the cost of purchasing the additional quantity q_a at the same price p in the second stage t_2. The conditional expectation $\Pi(Q, q_a, I)$ represents the buyer's profit at t_2.

And we will work with the following notations in the solution development:

$$\mathrm{x}^+ = \max(0, \mathrm{x}) \quad \text{and} \quad \mathrm{x} \wedge \mathrm{y} = \min\,(\mathrm{x}, \mathrm{y})$$

The total revenue $TR = r \cdot \min(D, Q + q_a)$ depends on the final quantity sold. If the demand is higher than $Q + q_a$ we will assume that we will sale all the quantity bought. However, if our demand is lower than our total quantity ordered, we only will sell the demand quantity.

The storage costing $SC = s \cdot max(0, Q + q_a - D)$ is only taken into account if the demand is lower than the total ordered quantity. So if we cannot sell the whole quantity we have a storage cost in order to store the goods in our warehouse.

Therefore, our problem is to determine the optimal purchasing decisions $(Q^*, {q_a}^*)$ that maximize the expected benefit.

The demand D follows a uniform distribution U(0,100). We will denote h(z) for the demand density, and will assume that it will be strictly increasing in z.

The Probability Density Function for uniform distribution is:

$$h(z) = \begin{cases} \dfrac{1}{b-a} & a \leq z \leq b \\ 0 & otherwise \end{cases}$$

In our particular case:

$$h(z) = \begin{cases} \dfrac{1}{100} & 0 \leq z \leq 100 \\ 0 & otherwise \end{cases}$$

8.1 Optimal solution

Let's remember the buyer's optimal profit π^*

$$\pi^* = max_{Q\geq 0}\{E\big(\Pi(Q, q_a, I)\big)\}$$

where

$$\Pi(Q, q_a) = \{r \cdot \min(D, Q + q_a) - s \cdot max(0, Q + q_a - D) - p \cdot (Q + q_a) - m - c \cdot I\}$$

We first solve the problem:

$$\Pi(Q, q_a^*) = E([r \cdot (D \wedge (Q + q_a^*)) - s \cdot (Q + q_a^* - D)^+ - p \cdot (Q + q_a^*) - m - c \cdot I$$

$$= r \cdot \int_0^{Q^*+q_a^*} z \cdot h(z)dz + r \cdot (Q + q_a^*) \cdot \int_{Q^*+q_a^*}^{100} h(z)dz$$

$$- s \cdot \int_0^{Q^*+q_a^*} [Q + q_a^* - z] \cdot h(z)dz - p \cdot (Q + q_a^*) - m - c \cdot I$$

$$= r \cdot \frac{z^2}{200}\Big]_0^{Q+q_a^*} + r \cdot (Q + q_a^*) \cdot \frac{z}{100}\Big]_{Q+q_a^*}^{100} - s \cdot \frac{Q \cdot z}{100} + \frac{q_a^* \cdot z}{100} - \frac{z^2}{200}\Big]_0^{Q+q_a^*} - p \cdot (Q + q_a^*) - m - c \cdot I$$

$$\boxed{\Pi(Q, q_a^*) \ = \frac{r \cdot (Q + q_a^*)^2}{200} + r \cdot (Q^* + q_a^*) - s \cdot \frac{(Q + q_a^*)^2}{200} - p \cdot (Q + q_a^*) - m - c \cdot I}$$

Now we can differentiate the equation with respect q_a^* and set to 0:

$$\frac{\partial \Pi(Q, q_a^*)}{\partial q_a^*} = -Q \cdot \frac{r - s}{100} - q_a^* \cdot \frac{r - s}{100} + r - p = 0$$

Giving as a result the following expression:

$$\boxed{q_a^* = \frac{(r - p) \cdot 100}{(r - s)} - Q}$$

From now, we can calculate the optimal extra quantity q_a^* for a given Q.

Nevertheless, this optimal quantity will depend of the profit conditions in each case. As we will explain forward, the conditions of high profit and low profit will limit our optimal extra quantity because of the fractiles we will work with. As we will explain forward, the quantity Q will be fixed, and this will cause many limitations in our optimization model.

As Maurice E. Schweitzer defines on Management Science's 2000 article, there is an optimal order quantity for every profit condition. So we will have two optimal ordering quantities, one for the high profit condition and the other one for the low profit condition.

In our case, as the base quantity is fixed, we are at a disadvantage with the low profit condition. As the result for q_a^* might be negative for a great number of the base order quantity values. This fact is creating a unstable solution set which is not completely compatible with our experiment. In order to adapt our model for the experiment we will develop, we can use a relaxation method of the problem.

For this reason, we must add a parameter in the above equation so that we can work under all possible conditions. This is because we will develop our work with limited parameters. As the base quantity is a fixed value, and is the key of our limitations, we will relax the equation variable adding a parameter called δ in our final expression:

$$\boxed{q_a^* = \frac{(r - p) \cdot 100}{(r - s)} - \delta \cdot Q}$$

This δ relaxes our variable Q adapting it to the profit conditions we are working on each moment. It describes the high/low profit condition, as the following expression:

$$\delta = \frac{r-p}{r-s}$$

So, from now, we will study separately the high profit and the low profit conditions.

Finally, the final profit function is:

$$\boxed{\pi^* = -p \cdot (Q+q_a^*) + \frac{r \cdot (Q+q_a^*)^2}{200} + r \cdot (Q+q_a^*) - s \cdot \frac{(Q+q_a^*)^2}{200} - m - c \cdot I}$$

We can check that this results the maximum point differentiating with respect q_a^* again and seeing that the sign of the second derivate is negative:

$$\frac{\partial^2 \Pi(Q, q_a^*)}{\partial {q_a^*}^2} = -\frac{r+s}{100} \text{ which is always} < 0$$

8.2 The demand treatment

From this, we have that our demand D follows a uniform distribution U(a,b) being a = 0, and b = 100.

The Probability Distribution Function is:

$$H(z) = \begin{cases} 0 & z < a \\ \dfrac{z-a}{b-a} & a \leq z \leq b \\ 1 & z > b \end{cases}$$

In our particular case:

$$H(z) = \begin{cases} 0 & z < 0 \\ \dfrac{z}{100} & 0 \leq z \leq 100 \\ 1 & z > 100 \end{cases}$$

And the Probability Density Function is:

$$h(z) = \begin{cases} \dfrac{1}{b-a} & a \leq z \leq b \\ 0 & otherwise \end{cases}$$

In our particular case:

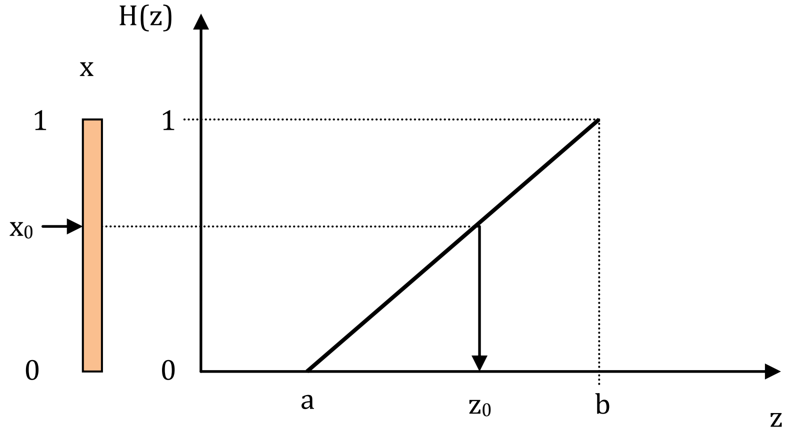
$$h(z) = \begin{cases} \dfrac{1}{100} & 0 \leq z \leq 100 \\ 0 & otherwise \end{cases}$$

In order to simulate the uniform distribution, we will use the random value method. We can suppose that we want to generate random values x_i of a particular statistical situation whose probability density function is h(z). The cumulative distribution function H(z) is defined in the interval (0,1). From here, we can generate random numbers (x) uniformly distributed in the same range, and establish the relationship H(z) = x.

In fact, "x" is the probability that the random variable assumes a value less than z. Therefore, it is possible to find the inverse function $H^{-1}(x)=z$. So we can find the demand random values from the random variable x both uniform distributed (see the following figure). Where $H^{-1}(x)=z$ is the inverse transform of x (defined on the interval [0,1] in the domain of z). Then a random number x_0 gives us through this transformation, a simulated value z_0 of the variable z.

For the theoretical continue distributions it is used this mathematical method, which requires to formulate the cumulative distribution H(z) and solve it for the point where the function is equal to the random number "x":

$$x = H(z) = \int_{-\infty}^{\infty} h(z)dz \quad \Rightarrow \quad z = H^{-1}(x)$$



Therefore, in our case we will simulate the demand with the next equation:

$$x = H(z) = \frac{z-a}{b-a} = \frac{z}{100}$$

$$z = 100 \cdot x$$

$$D = 100 \cdot x$$

Where $x \in [0,1]$

From here, we will simulate that for each period, we will have a random demand and we will calculate the extra quantity for each period.

8.2.1 The generation of random values for the simulation

The simulation is a numerical method for logic and mathematic models characterized by the fact of testing a system repeatedly. Therefore, we can experiment a model in order to infer the behavior of a real situation.

The simulation method can be applied in the inventory management in order to evaluate several policies related with de inventory flowing and the demand planning with probability distributions.

From here, it is needed to generate a sequence of random numbers in order to start the simulation for our demand distribution. Actually, the computers have random generators which results satisfy the random tests of statistic properties.

We can use the random generator from the Microsoft Excel program. it will generate our random numbers for our variable x in order to simulate different values for our demand distribution.

The decision of using this kind of method in because a random number of the sequence has the same probability of occurrence. This probability is the same for the uniform distribution of our defined demand, so it can be adapted to our problem.

9 Experiment hypothesis

In this section we will describe the hypothesis and conditions we will work with the further experiment.

Firstly we must decide which parameters are going to be fixed and which ones are going to be variable. In order to think about this, we have to remember the objectives of the investigation. Our main goal is to relate our subject's security quantity decision with three factors: the cash deposit m, the high profit and low profit conditions and the risk taken.

So it's obvious that if the objective is to relate the variation of the security quantity in the decisions with these parameters, they will have to be variable in order to see the relationship.

9.1 The base quantity

The base quantity order is the first parameter of our problem we are going to focus with. For this, the uniform distribution of our demand will favor us to make a decision of fixing de base quantity order. As we know, the mean of a uniform distribution can be determined by the following:

$$E\ [z \sim U(a,b)] = \frac{a+b}{2}$$

So in our particular case:

$$E\ [D \sim U(0{,}100)] = \frac{0+100}{2} = 50$$

In a uniform distribution all numbers between a and b have the same probability of occur. So the mean of the distribution means the intermediate point, the half probability to occur or not. Therefore, we can consider the mean of the distribution a good candidate for our base quantity order to be fixed. So the hypothesis 1 is the following:

$$(1)\ \text{Base Quantity Order} = \text{Q} = \text{E[D]} = 50$$

9.2 High and Low profit conditions

The next parameters we will focus with now are the prices of selling r, purchasing p and storage s. For making this we will use the levels of high and low profit we will work with. As it was explained at chapter 8.2, the factor 2 will help us for relating both prices:

$$b = \frac{r-p}{r-s}$$

For a high profit condition, $b = 0.75$ and correspondingly for a low profit condition $b = 0.25$. Therefore, only one of the prices must be fixed, and the other one will be directly defined on the conditions. The decision has been to fix the selling price r in 8\$. So the purchasing price will have two levels in order to satisfy the profit conditions:

$$(2)\ r = 9\$$$

$$(3)\ High\ Profit\ Condition = b = 0.75 = \frac{9-p}{9-1} \rightarrow p = 3\$$$

$$(4)\ Low\ Profit\ Condition = b = 0.25 = \frac{9-p}{9-1} \rightarrow p = 7\$$$

Prices	Low level	High level
p	3 \$	7 \$
r	9 \$	

Table 1 - Hypothesis for the purchasing and selling prices

9.3 Storage cost

Regarding the storage cost, normally it is considered to be a little percentage of the selling price. It is very common to be about 10% of the selling price. In our case with this percentage the storage cost would be of 0,9\$. In order to work with integers and simplify the results, it has been decide the storage cost to be 1\$, which suppose a 11.1% of the selling price r.

$$(5)\ Storage\ cost = s = 0.111 \cdot r = 0.111 \cdot 9 = 1\$$$

9.4 Security cost

Respecting the security deposit, it is one of our main goals to relate it to the security quantity order decisions. Therefore, in order to analyze the relationship between them, we must make the parameter variable. Only this way we will be able to study the variation of one with the variation of the other.

Thus, we will fix a low and high level for the security deposit as follows:

Security deposit	Low level	High level
m	20 \$	50 \$

Table 2 - Hypothesis for the security deposit

The choice of the range of this cost levels is related to the storage cost. The theory of reserve production capacity to the supplier's is directly related to the risk of an uncertain demand increase and when the base quantity order is insufficient. This situation can also be seen from the perspective of the safety stocks in which can be stored product "just in case". Therefore, it was decided to link the security deposit to the storage cost in which we would keep the base order quantity for the next season in the worst case (high level), or the 20% of the maximum demand in a more relaxed case (low level).

9.5 Optimal extra quantity order

The optimal extra quantity order will be calculated by the mathematical model equation:

$$\boxed{q_a^* = \frac{(r-p)\cdot 100}{(r-s)} - \delta \cdot Q}$$

As the parameter δ depends on the profit conditions, we will work with two different optimal extra quantities in each condition case. For the high profit condition we have the following:

$$q_a^* = \frac{(r-p)\cdot 100}{(r-s)} - \delta \cdot Q = \frac{(9-3)*100}{(9-1)} - 0.75*50 = 37.5$$

Therefore, the total quantity to order will be:

$$Q_{\text{total}} = Q + q_a^* = 50 + 37.5 = 87.5$$

For the low profit condition the extra quantity order is:

$$q_a^* = \frac{(r-p)\cdot 100}{(r-s)} - \delta \cdot Q = \frac{(9-7)*100}{(9-1)} - 0.25*50 = 12.5$$

Therefore, the respective total quantity to order will be:

$$Q_{\text{total}} = Q + q_a^* = 50 + 12.5 = 62.5$$

9.6 Optimal Profit

The optimal profit will be calculated by the mathematical model expression:

$$\boxed{\pi^* = -p\cdot(Q+q_a^*) + \frac{r\cdot(Q+q_a^*)^2}{200} + r\cdot(Q+q_a^*) - s\cdot\frac{(Q+q_a^*)^2}{200} - m - c\cdot I}$$

This expression depends of the combination of the 4 levels conditions, so we will work with different optimal profits.

For the High Profit - High Security Condition, the final optimal profit is:

$$\begin{aligned}\pi^* = -p\cdot(Q+q_a^*) + \frac{r\cdot(Q+q_a^*)^2}{200} + r\cdot(Q+q_a^*) - s\cdot\frac{(Q+q_a^*)^2}{200} - m - c\cdot I \\ = -3\times 87.5 + \frac{9\times 87.5^2}{200} + 9\times 87.5 - 1\times\frac{87.5^2}{200} - 50 - 10\times 1 \text{ or } 2 \\ = 761.25 \text{ or } 771.25\end{aligned}$$

For the Low Profit - High Security Condition, the final optimal profit is:

$$\pi^* = -p \cdot (Q + q_a^*) + \frac{r \cdot (Q + q_a^*)^2}{200} + r \cdot (Q + q_a^*) - s \cdot \frac{(Q + q_a^*)^2}{200} - m - c \cdot I$$
$$= -7 \times 87.5 + \frac{9 \times 87.5^2}{200} + 9 \times 87.5 - 1 \times \frac{87.5^2}{200} - 50 - 10 \times 1 \text{ or } 2$$
$$= 211.25 \text{ or } 221.25$$

For the High Profit - Low Security Condition, the final optimal profit is:

$$\pi^* = -p \cdot (Q + q_a^*) + \frac{r \cdot (Q + q_a^*)^2}{200} + r \cdot (Q + q_a^*) - s \cdot \frac{(Q + q_a^*)^2}{200} - m - c \cdot I$$
$$= -3 \times 87.5 + \frac{9 \times 87.5^2}{200} + 9 \times 87.5 - 1 \times \frac{87.5^2}{200} - 20 - 10 \times 1 \text{ or } 2$$
$$= 791.25 \text{ or } 801.25$$

For the Low Profit - Low Security Condition, the final optimal profit is:

$$\pi^* = -p \cdot (Q + q_a^*) + \frac{r \cdot (Q + q_a^*)^2}{200} + r \cdot (Q + q_a^*) - s \cdot \frac{(Q + q_a^*)^2}{200} - m - t \cdot I$$
$$= -7 \times 87.5 + \frac{9 \times 87.5^2}{200} + 9 \times 87.5 - 1 \times \frac{87.5^2}{200} - 20 - 10 \times 1 \text{ or } 2$$
$$= 251.3 \text{ or } 241.3$$

Note that we have two different results for each case, this is because the final profit depends whether we finally take the decision of ordering the extra quantity order or not.

10 The experiment

Having developed a theoretical background of the above, we are going to carry out a real experiment in order to analyze the decision making behavior of a sample. This experiment investigates inventory orders in a repeated environment. The demand distribution is known and subjects made decisions for both high and low profit margin products.

10.1 Design

We recruited 40 subjects from Beihang University who are studying several majors. The sample used is going to be half Chinese population and half Spanish population. Each subject received the same experiment description.

First of all, a survey has been designed with two different parts. The first one features only 5 general questions about the gender, nationality, occupation and knowledge about economics and supply flexibility. With this part we can classify respondents to analyze the future results with different parameters or variables, and we will be able to make better comparisons. It will also help us to look for relationships between the result variation and the parameters variation.

The second part features 12 more specific questions which can help us to measure the risks that the participants take in their everyday life. We will measure the risk of each participant and will see if it is related to their decision making in the experiment.

See the survey questions in the tables bellow (Table 3 and Table 4)

1.Your Gender		***2. Are you studying or working?***	
A	Male	A	Studying
B	Female	B	Working
3. Have you studied economics and investment?		***4. Do you have knowledge about Supply Flexible?***	
A	Professional Certificate	A	Yes
B	Finance Graduate	B	No
C	Some experience		
D	Some		
E	No idea		
5. Which is your country			
A	China		
B	Spain		

Table 3 - General Questions

6. If you drive, do you use the safety belts?	7. How often do you get drunk?
A Every time B Often C Sometimes D Seldom E Never	A Never B Seldom C Sometimes D Often E Every time
8. Do you use the crosswalk to cross the roads?	***9. If the salaries were equal, what would you prefer to be?***
A Every time B Often C Sometimes D Seldom E Never	A Librarian B Pilot
10. Do you prefer a fixed salary or with adjustments because of your performance?	***11. Do you break traffic lights?***
A Fixed Salary B Salary adjustments with performance	A Every time B Often C Sometimes D Seldom E Never
12. Do the cautious car drivers make you feel impatient?	***13. Do you like to bet?***
A No B Yes	A I don't like B Do not dislike C I usually like D I like E I especially like
14. Do you close doors and windows in the night?	***15. When someone jumps the queue, do you complain?***
A Every time B Often C Sometimes D Seldom E Never	A Never B Seldom C Sometimes D Often E Every time
16. Would you like to try extreme sports?	***17. Which of the followings do you think that best describes yourself?***
A No B Yes	A I'm not willing to take risks B I need to considerate carefully before willing to take risks. C I am an adventurer

Table 4 - Specific questions

After making the participants answer the survey, we proceed to the experiment. Each subject received a computer program (Microsoft Excel) that described an inventory problem for a retailer. See the following experiment description for subjects:

" As retailers, our suppliers have to accept our order quantities in accordance with provision of goods. In the negotiation of the ordering quantities, the suppliers can maintain a production capacity for us. For this king of negotiation the retailer must pay a deposit fee in order to reserve this production capacity for the supplier in the first stage of the ordering season. The reservation of production capacity includes raw materials, production line, labor and storage space. If the updated demand information shows that the basic quantity ordered by retailers is not enough to cover the forecast and this information is before the selling season, the supplier is required to provide the guaranteed quantity of goods. The price of these extra quantity order is the same as the basic order.

Your role as a retailer, is to take the decision of which security quantity it's better to reserve in order to have the maximum profit. You will have to decide the extra quantity in 4 different cases. (with low profit, high profit, high reservation fee and low reservation fee). The parameters of the experiment are the following:

p - Purchase price. The unit price that we are buying to the supplier. We will work with two levels for it in order to experiment with the high and low profit situations. [$/unit]

r - Market price of our products. The price we are going to sell the products for our customers. We will work with a fixed market price. [$/unit]

m - Security deposit in order to guarantee the reservation of production capacity. We will work with two levels in order to experiment with high and low deposit. [$]

D- Demand of our product, which follows a uniform distribution between 0 and 100. U(0,100). We will work with random numbers from 0 to 100 which have the same probability to occur. [units]

s - Unit storage cost. We will have a storage cost in case that our demand is lower than our total ordered quantity. [$/unit]

c - Ordering cost. We will have an ordering cost for each order that we make. If we order an extra quantity, the ordering cost will double (2·c). [$/order]

Q - The base quantity order, we will work with it fixed in 50 units. [units]

q_a *- The extra quantity that subjects are going to decide. [units]*

Now, given the following parameters limit, you need suppliers to provide you with a guarantee amount q_a. How much?"

See in the table below the resume of the parameters we will work with according with the hypothesis we explained at Chapter 9:

Current market information		
Parameters	***Low Level***	***High Level***
Purchase Price [p]	**3**	**7**
Market price [r]	**9**	
Security deposit [m]	**20**	**50**
Market Demand [D]	**U(0,100)**	
Unit Storage costing [s]	**1**	
Ordering cost [c]	**10**	**20**
Basic Order Quantity [Q]	**50**	

Table 5 - Parameter's levels

10.2 Decision description

After answering the survey and reading the experiment description, subjects are able to make the experiment. It will consist in make 4 decisions of the security quantity to be, combining the 4 variable levels. Therefore, we will have a total of 160 experiments to analyze.

The decisions of each subject will be made for the 4 possible situations of high/low profit and high/low security deposit combination. See the following table with the order of the parameter's level:

Experiment	***Purchase price (p)***	***Security deposit (m)***
1	+	+
2	-	+
3	+	-
4	-	-

Table 6 - Experiment order for parameter's levels

The subjects must decide which would be the best quantity to order under the given conditions with a totally demand uncertainty. The only demand information that they can have is that it is uniformly distributed between 0 and 100. They also will know about the fixed base order quantity, and they will decide if it's worth it to reserve a extra quantity or not.

The microchips are sold for 9$ and salvaged for 1$. In the low profit condition, the microchips are purchased for 7$ and in the high profit condition they are purchased for 3$. Knowing this, we can calculate the critical rates[1] of the two fractiles we are going to work with:

$$High\ Profit\ Condition\ \ \delta = \frac{r-p}{r-s} = \frac{9-3}{9-1} = 75\%$$

$$Low\ Profit\ Condition\ \ \delta = \frac{r-p}{r-s} = \frac{9-7}{9-1} = 25\%$$

Thus, the corresponding expected profit-maximizing order quantities are:

<u>High profit condition:</u>

$$\boxed{q_a^* = \frac{(r-p)\cdot 100}{(r-s)} - \delta \cdot Q = \frac{(9-3)*100}{(9-1)} - 0.75*50 = 37.5}$$

<u>Low profit condition:</u>

$$\boxed{q_a^* = \frac{(r-p)\cdot 100}{(r-s)} - \delta \cdot Q = \frac{(8-6)*100}{(8-1)} - 0.25*50 = 12.5}$$

Therefore, the total optimal quantities to order are:

<u>High profit condition:</u>

$$Q + q_a^* = 50 + 37.5 = 87.5$$

<u>Low profit condition:</u>

$$Q + q_a^* = 50 + 12.5 = 62.5$$

Before making the decisions, the subjects are able to see the information of all parameters in each case. Also, they can see the results from prior rounds done in order to improve the next profits experiments.

[1] The critical rate is the parameter δ that was described at the end of Chapter 9. This parameter will help us to calculate the optimal extra quantity in the high profit and low profit conditions.

10.2 Extra quantity decision

Now we have the optimal solution for calculating the extra quantity. However, the point of our problem is to make the decision of ordering that quantity or not. Hence, to decide if the order of an extra quantity must be made, we will study three factors that will help us to take the decision. These factors are directly related to parameters of the problem that we will change in order to simulate the largest number of possible cases.

Factor 1 - Security deposit m

We will work with a ratio a

$$a = \frac{Cash\ deposit}{Extra\ quantity * cost} = \frac{m}{q_a^* \cdot p}$$

This ratio help us to relate the amount of the cash deposit with the cost of ordering an extra quantity. This way we can quantify whether is worthwhile or not to order an extra quantity depending on the cash deposit.

From now, we can establish some limits for this ratio. If it is higher than 0,5 we can consider it in the high level. And therefore, if it's lower than 0,5 we will considerate it in the low level. For future studies and simulations we will fix this value in the two levels:

Ratio	Low Level	High Level
a	0.25	0.75

Factor 2 - High profit/Low profit

We will work whit a ratio b

$$b = \frac{r - p}{p}$$

This ratio help us to know the profit level in which the businesses are. As with the prior ratio we can assume that if it is higher than 0,5 we will considerate high profit, and if it is lower than 0,5 we will considerate it low profit.

Factor 3 - Risk taken

In the Chapter 5 we have already defined the risk modeling we are going to work with. Through the survey done, we will calculate for each subject the risk vector that will classify them in a risk behavior level.

11 Results

11.1 Survey Answers

The survey's answers have been encoded in order to transform the results in numbers to work with. The key is the following:

Letter answer	*Encoded number*
A	1
B	2
C	3
D	4
E	5

Table 7 - Key for encoding survey answers

This encode follows the rule that such as greater is the number, greater is the risk behavior on the answer. So, it will help us to catalog the risk appetite of each subject in a simply and effectively way.

The Spanish results for the survey are the following:

	SPANISH																			
	T1	*T2*	*T3*	*T4*	*T5*	*T6*	*T7*	*T8*	*T9*	*T10*	*T11*	*T12*	*T13*	*T14*	*T15*	*T16*	*T17*	*T18*	*T19*	*T20*
Q1	1	1	1	1	1	2	1	1	1	1	2	2	2	1	1	1	1	1	1	1
Q2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q3	3	4	4	4	3	4	4	4	4	3	3	1	4	4	4	3	1	3	3	4
Q4	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2
Q5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Q6	3	4	2	1	3	1	1	3	3	4	4	3	1	4	1	2	2	2	1	2
Q7	4	4	1	2	4	3	1	3	2	4	4	2	2	3	3	4	1	4	3	4
Q8	2	4	4	3	1	4	3	3	3	1	1	1	1	2	3	2	1	2	3	4
Q9	2	2	2	1	2	1	2	2	2	1	1	1	2	2	2	2	2	2	1	1
Q10	2	2	2	2	2	2	1	2	2	2	2	1	2	2	2	2	2	2	2	2
Q11	4	4	2	3	3	1	2	5	3	4	4	5	5	5	5	5	4	3	3	4
Q12	2	2	2	2	2	1	2	2	2	1	2	2	1	2	2	2	2	2	1	2
Q13	5	4	3	3	2	2	1	1	4	4	3	3	4	5	1	3	2	3	3	2
Q14	3	3	1	2	4	3	2	4	3	3	4	3	3	4	3	3	3	3	4	2
Q15	5	4	4	5	3	4	3	4	5	5	3	4	4	3	1	4	3	5	1	3
Q16	2	2	2	2	2	1	2	2	2	2	2	2	1	2	2	2	2	1	1	2
Q17	3	2	2	2	3	1	2	2	3	2	2	1	2	3	2	2	2	1	1	3

Table 8 - Spanish testers survey answers

The Chinese results for the survey are the following:

	CHINESE																			
	T21	**T22**	**T23**	**T24**	**T25**	**T26**	**T27**	**T28**	**T29**	**T30**	**T31**	**T32**	**T33**	**T34**	**T35**	**T36**	**T37**	**T38**	**T39**	**T40**
Q1	2	2	2	1	1	1	2	1	1	1	2	1	1	1	2	2	2	2	2	1
Q2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q3	3	4	3	4	5	4	4	4	5	4	5	5	4	5	4	5	4	4	5	5
Q4	1	1	1	1	2	2	2	2	2	1	2	2	2	2	2	2	1	1	2	2
Q5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q6	3	3	4	3	4	1	3	4	3	1	1	3	4	3	1	4	3	4	4	4
Q7	3	3	3	1	3	1	2	4	3	2	1	4	2	4	1	2	1	1	1	3
Q8	2	2	2	1	2	2	2	3	2	1	2	2	2	2	2	2	2	2	2	2
Q9	1	2	1	1	1	2	2	2	2	1	1	2	2	2	1	2	1	2	2	1
Q10	2	2	2	1	2	2	1	2	2	1	1	2	1	2	1	2	2	2	2	1
Q11	3	4	4	4	3	3	4	4	4	4	4	4	3	3	3	4	3	4	3	3
Q12	1	2	2	2	1	1	2	2	1	1	1	2	2	2	1	2	1	1	2	1
Q13	4	4	3	3	4	4	3	2	4	2	4	3	4	4	3	5	3	3	4	3
Q14	3	4	4	3	3	1	4	3	4	3	3	4	2	2	2	4	4	2	4	3
Q15	5	4	3	2	4	3	3	5	4	2	3	3	2	3	2	5	2	2	4	3
Q16	1	2	2	2	2	2	2	2	2	1	1	2	1	2	1	2	2	2	2	2
Q17	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2

Table 9 - Chinese testers survey answers

The count for the total answers is the following:

TOTAL ANSWERS																	
Answer	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Q14**	**Q15**	**Q16**	**Q17**
1	26	40	2	8	20	10	10	8	16	9	1	14	3	2	2	9	5
2	14	0	0	32	20	5	8	21	24	31	2	26	6	7	6	31	30
3	0	0	9	0	0	13	11	7	0	0	14	0	15	18	13	0	5
4	0	0	21	0	0	12	11	4	0	0	17	0	13	13	11	0	0
5	0	0	8	0	0	0	0	0	0	0	6	0	3	0	8	0	0

Table 10 - Count answers for the total sample

Transforming it to percentages:

TOTAL PERCENTAGES																	
Answer	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Q14**	**Q15**	**Q16**	**Q17**
1	65%	100%	5%	20%	50%	25%	25%	20%	40%	23%	3%	35%	8%	5%	5%	23%	13%
2	35%	0%	0%	80%	50%	13%	20%	53%	60%	78%	5%	65%	15%	18%	15%	78%	75%
3	0%	0%	23%	0%	0%	33%	28%	18%	0%	0%	35%	0%	38%	45%	33%	0%	13%
4	0%	0%	53%	0%	0%	30%	28%	10%	0%	0%	43%	0%	33%	33%	28%	0%	0%
5	0%	0%	20%	0%	0%	0%	0%	0%	0%	0%	15%	0%	8%	0%	20%	0%	0%

Table 11 - Answers percentage for the total sample

Now let's see graphically the answers of each question:

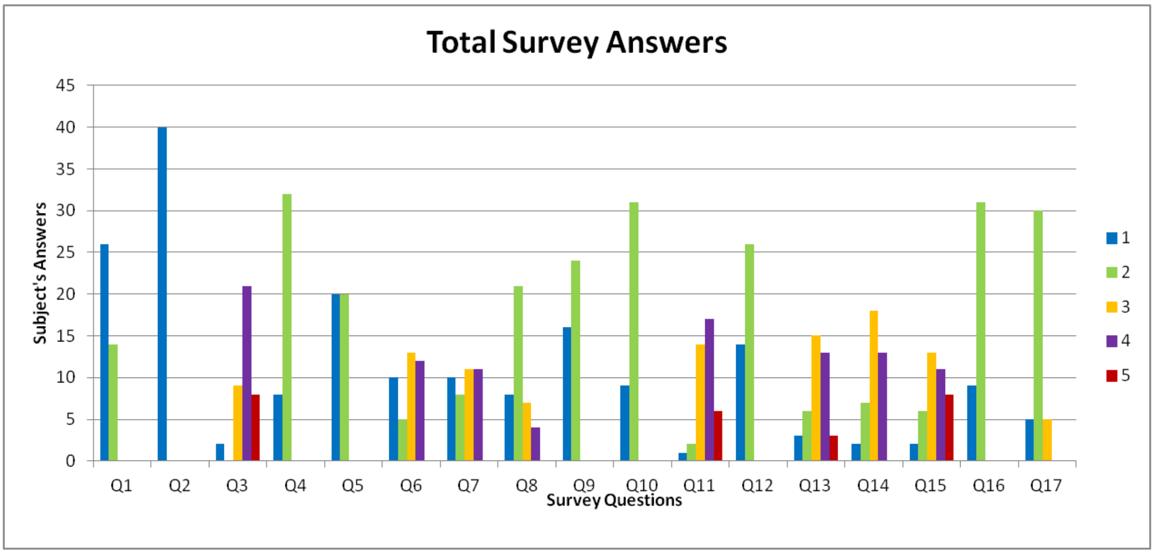


Figure 4 - Column graph for the survey answers

And the percentage graph distribution is the following:

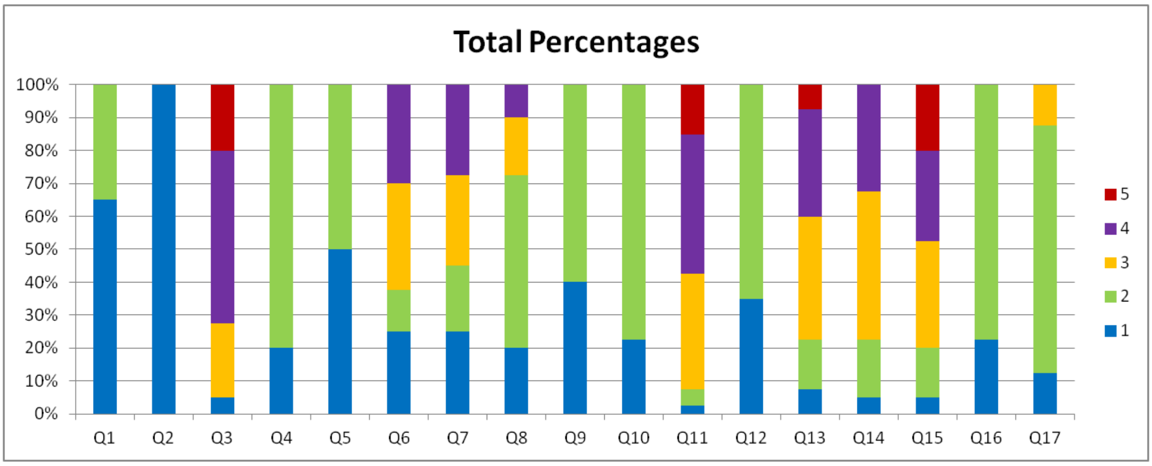


Figure 5 - Percentage graph for the survey answers

11.2 Risk results

For the risk evaluation we will follow the method explained in chapter 7.2. The fact is that our survey has 17 questions in total, but we are only going to use 10 of them, in order to get the matrix dimensions as in the theoretical model. It has been chosen the most revealing questions about the respondent's risk behavior.

The questions used are: Q6, Q7, Q9, Q10, Q11, Q12, Q13, Q14, Q15 and Q16. From here, we will use the encoded answers in order to calculate the vectors and R matrices for each subject. (See the R matrices attached in the Annex A).

Therefore, our common factor variance vector is the following:

$$a_i = \frac{H_i^2}{\sum H_i^2}$$

$$A = \{a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9, a_{10}\}$$

In our particular case:

$$A = \{0.238, 0.229, 0.008, 0.004, 0.084, 0.007, 0.149, 0.066, 0.211, 0.004\}$$

And the risk vectors for each tester are the following:

Testers	V1	V2	V3	V4	V5	Maximum value	Maximum component	RISK LEVEL
T1	0,4445	0,2266	0,1584	0,0982	0,0724	0,4445	5	HIGH RISK
T2	0,4552	0,2864	0,2066	0,0269	0,0249	0,4552	5	HIGH RISK
T3	0,1057	0,0932	0,1559	0,2071	0,4382	0,4382	1	HIGH SAFE
T4	0,1691	0,0888	0,1319	0,2121	0,3981	0,3981	1	HIGH SAFE
T5	0,1475	0,1951	0,2533	0,2115	0,1926	0,2533	3	MEDIUM RISK
T6	0,1057	0,1224	0,1614	0,2025	0,4080	0,4080	1	HIGH SAFE
T7	0,0000	0,0423	0,0973	0,2381	0,6224	0,6224	1	HIGH SAFE
T8	0,2060	0,1934	0,2001	0,1766	0,2239	0,2239	1	HIGH SAFE
T9	0,2435	0,1645	0,1965	0,1919	0,2035	0,2435	5	HIGH RISK
T10	0,5186	0,2653	0,1614	0,0254	0,0294	0,5186	5	HIGH RISK
T11	0,3083	0,2570	0,2344	0,1142	0,0860	0,3083	5	HIGH RISK
T12	0,1728	0,1708	0,2261	0,2102	0,2201	0,2261	3	MEDIUM RISK
T13	0,2473	0,1381	0,1401	0,1419	0,3326	0,3326	1	HIGH SAFE
T14	0,3382	0,2258	0,1974	0,1390	0,0996	0,3382	5	HIGH RISK
T15	0,0672	0,0758	0,0932	0,2150	0,5488	0,5488	1	HIGH SAFE
T16	0,2872	0,1918	0,2047	0,1428	0,1734	0,2872	5	HIGH RISK
T17	0,0420	0,0807	0,1820	0,2519	0,4433	0,4433	1	HIGH SAFE
T18	0,2834	0,1707	0,1868	0,1676	0,1915	0,2834	5	HIGH RISK
T19	0,0332	0,1122	0,1526	0,2333	0,4688	0,4688	1	HIGH SAFE
T20	0,1563	0,1361	0,2196	0,2054	0,2826	0,2826	1	HIGH SAFE
T21	0,2435	0,2102	0,2156	0,1900	0,1407	0,2435	5	HIGH RISK
T22	0,2553	0,2464	0,2466	0,1468	0,1049	0,2553	5	HIGH RISK
T23	0,1940	0,2341	0,2573	0,1828	0,1317	0,2573	3	MEDIUM RISK
T24	0,0420	0,1158	0,1971	0,2507	0,3944	0,3944	1	HIGH SAFE
T25	0,2989	0,2551	0,2349	0,1192	0,0919	0,2989	5	HIGH RISK
T26	0,0744	0,1037	0,1216	0,2014	0,4989	0,4989	1	HIGH SAFE
T27	0,0752	0,1647	0,2589	0,2545	0,2467	0,2589	3	MEDIUM RISK
T28	0,4442	0,2206	0,1644	0,0715	0,0993	0,4442	5	HIGH RISK
T29	0,2553	0,2464	0,2452	0,1461	0,1070	0,2553	5	HIGH RISK
T30	0,0420	0,0385	0,1545	0,2487	0,5163	0,5163	1	HIGH SAFE
T31	0,1164	0,1254	0,1299	0,1812	0,4471	0,4471	1	HIGH SAFE
T32	0,1895	0,2333	0,2598	0,1863	0,1312	0,2598	3	MEDIUM RISK
T33	0,1932	0,1327	0,2067	0,1832	0,2841	0,2841	1	HIGH SAFE
T34	0,1888	0,2198	0,2533	0,1867	0,1514	0,2533	3	MEDIUM RISK
T35	0,0000	0,0466	0,1254	0,2511	0,5770	0,5770	1	HIGH SAFE
T36	0,4821	0,1884	0,1280	0,0756	0,1259	0,4821	5	HIGH RISK
T37	0,0332	0,1140	0,1983	0,2557	0,3988	0,3988	1	HIGH SAFE
T38	0,1608	0,1262	0,1677	0,1800	0,3653	0,3653	1	HIGH SAFE
T39	0,3321	0,2160	0,1627	0,0779	0,2113	0,3321	5	HIGH RISK
T40	0,1188	0,2191	0,2701	0,2268	0,1652	0,2701	3	MEDIUM RISK

Table 12 - V vector for each subject

Note that the subjects from 1 to 20 are the Spanish ones, and from 20 to 40 are the Chinese ones.

From here we can consider that the High Risk and Medium Risk results are people who love risking, and the High Safe results are people who love safety. As a result, there are 15 subjects who have risky behavior, 7 subjects who have medium risk behavior and 18 who have a safety behavior.

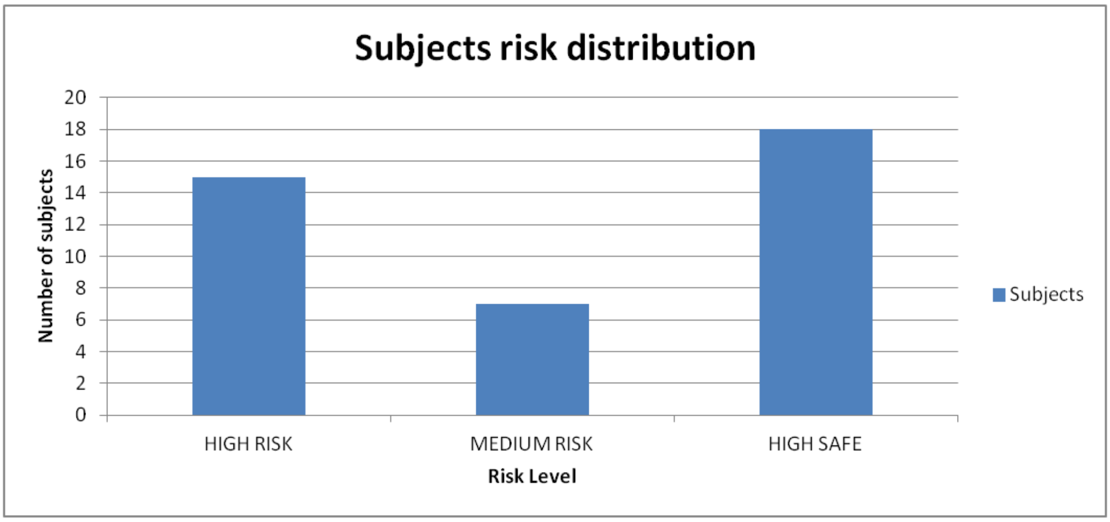


Figure 6 - Column Graph of the subject's classification

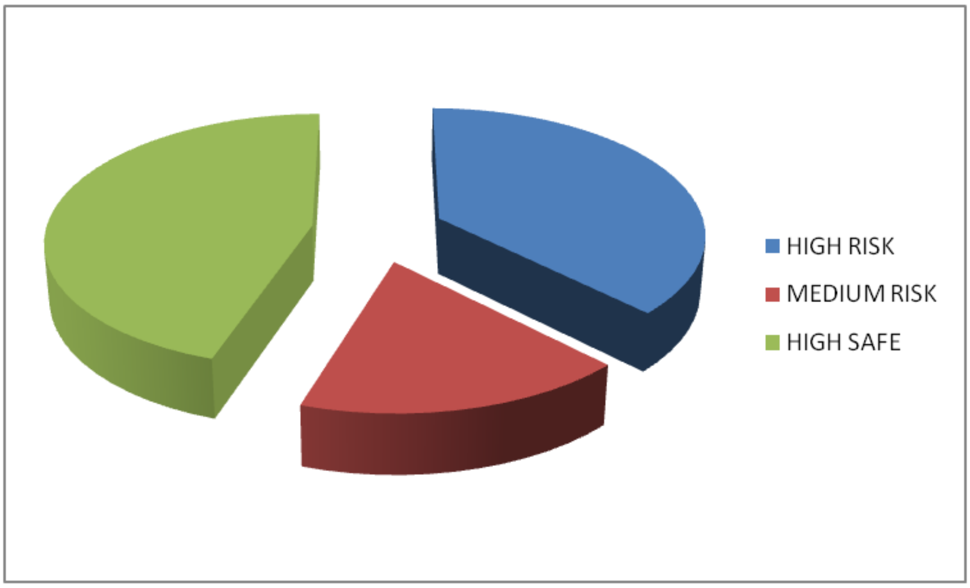


Figure 7 - Circle Graph of the subject's classification

11.3 Spanish results

In this chapter we will analyze graphically the extra quantity decisions in general results of the Spanish subjects gathering also between the 4 cases of the decision taken. See in the Annex B the Spanish decisions for the extra quantity order.

For the High Profit and High Security Cost, the Spanish results are the following:

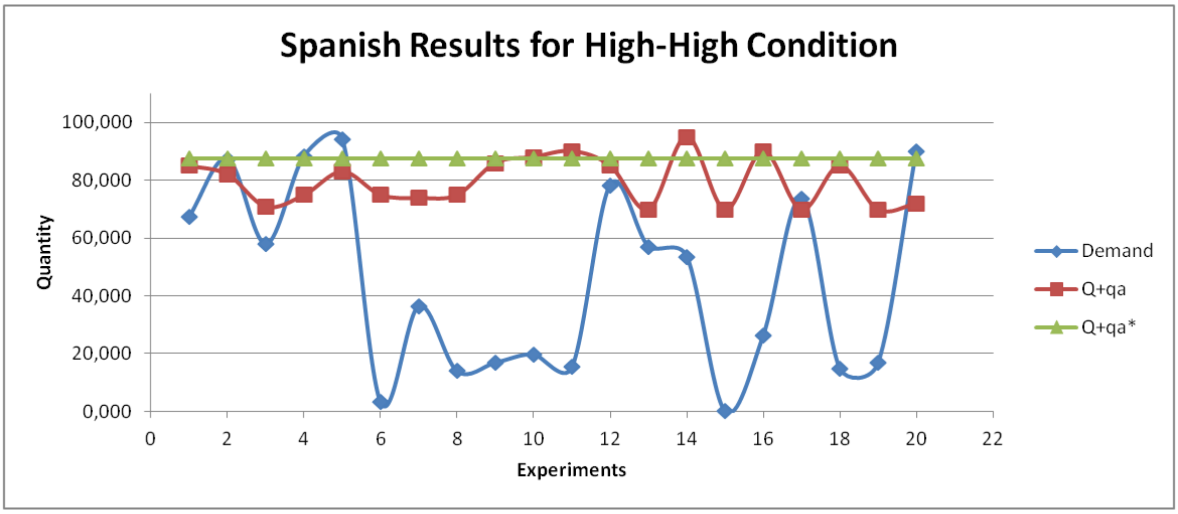


Figure 8 - Dispersion Graph of the Spanish results for High-High condition

As we can see graphically, the extra quantity order decisions lead to be lower than the optimal solution in this conditions. Nevertheless, it is needed a statistical study to have comprehensive conclusions.

For the High Profit and Low Security Cost, the Spanish results are the following:

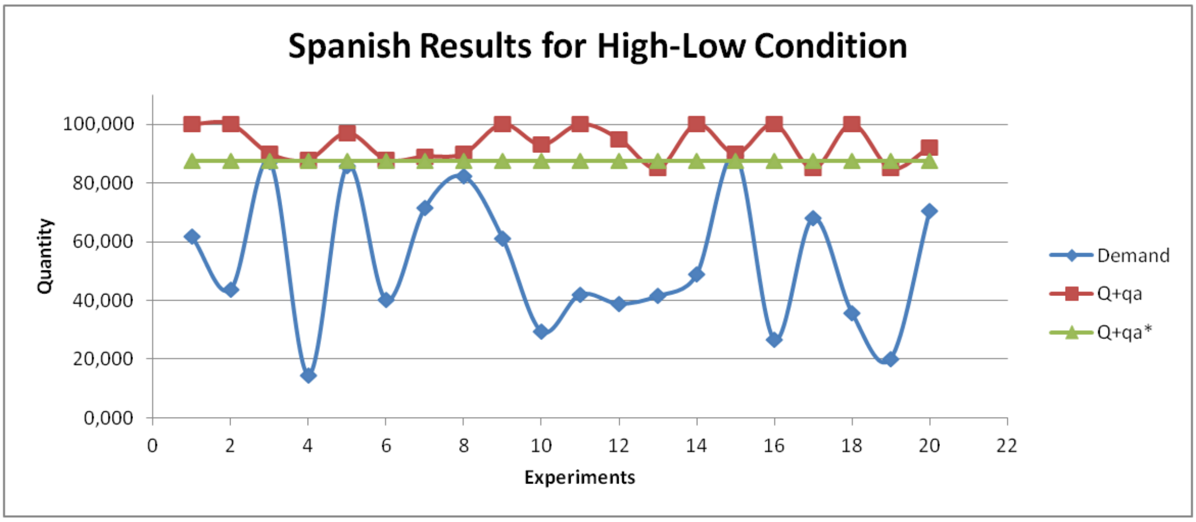


Figure 9 - Dispersion graph of the Spanish results for High-Low conditions

As we can see graphically, the extra quantity order decisions lead to be higher than the optimal solution in this conditions. Nevertheless, it is needed a statistical study to have comprehensive conclusions.

For the Low Profit and High Security Cost, the Spanish results are the following:

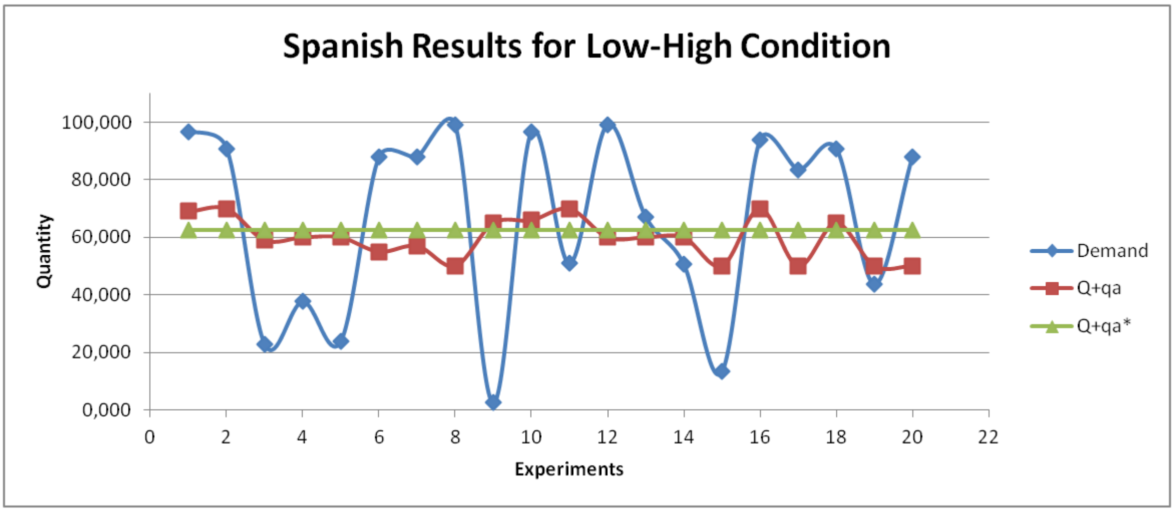


Figure 10 - Dispersion Graph of the Spanish results for Low-High conditions

For the Low Profit and Low Security Cost, the Spanish results are the following:

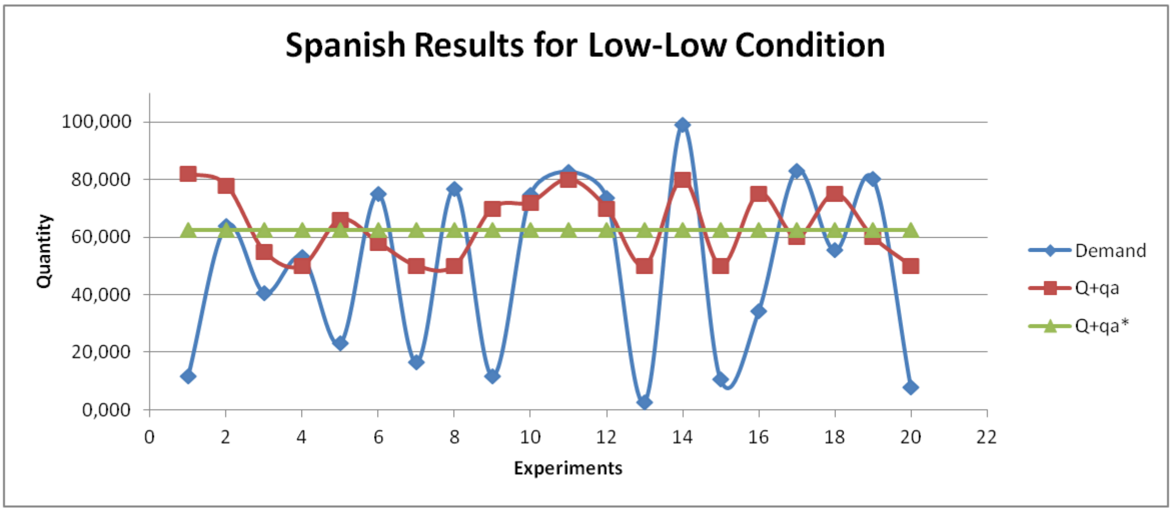


Figure 11 - Dispersion Graph of the Spanish results for Low-Low conditions

In this last 2 cases we can see that the trend of the ordered quantity decision is similar to the optimal one. Nevertheless, it is needed a statistical study to have comprehensive conclusions.

11.4 Chinese results

In this chapter we will analyze graphically the extra quantity decisions in general results of the Chinese subjects gathering also between the 4 cases of the decision taken. See in the Annex C the extra quantity order decisions.

For the High Profit and High Security Cost, the Chinese results are the following:

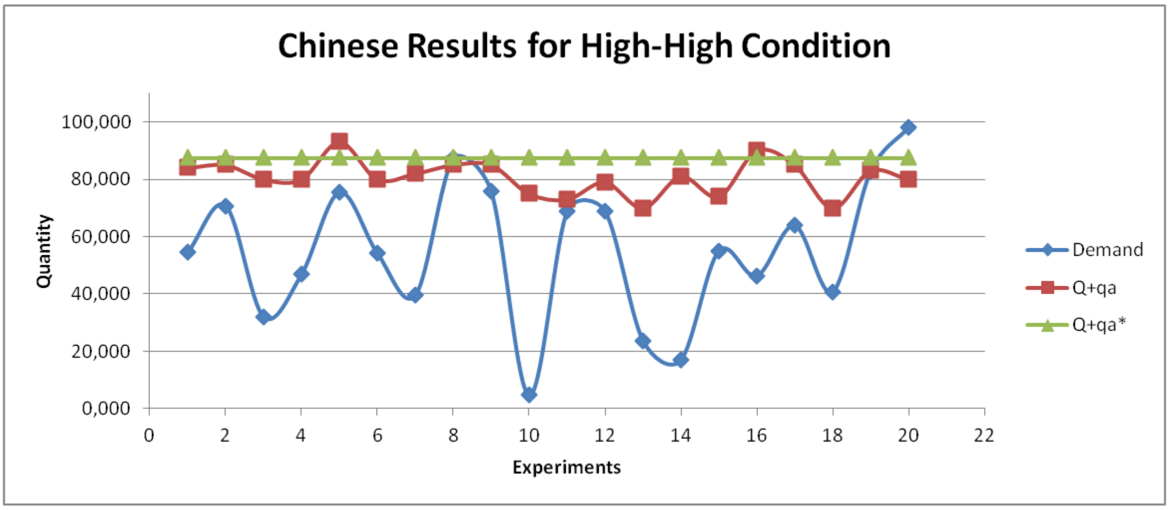


Figure 12 - Dispersion Graph of the Chinese results for High-High conditions

As we can see graphically, the extra quantity order decisions lead to be lower than the optimal solution in this conditions. Nevertheless, it is needed a statistical study to have comprehensive conclusions.

For the High Profit and Low Security Cost, the Chinese results are the following:

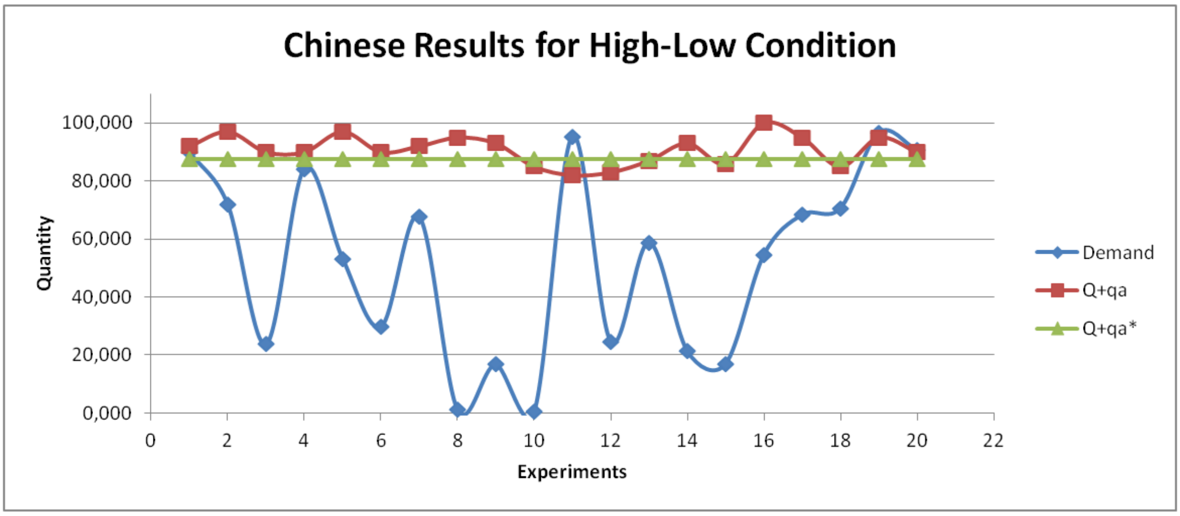


Figure 13 - Dispersion Graph of the Chinese results for High-Low conditions

As we can see graphically, the extra quantity order decisions lead to be higher than the optimal solution in this conditions. Nevertheless, it is needed a statistical study to have comprehensive conclusions.

For the Low Profit and High Security Cost, the Chinese results are the following:

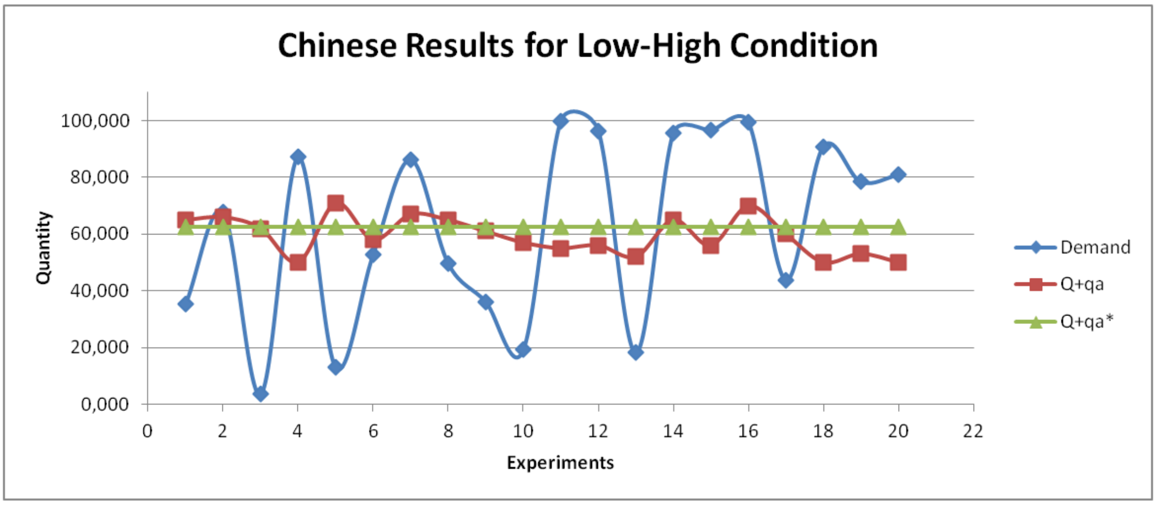


Figure 14 - Dispersion Graph of Chinese results for Low-High conditions

As we can see graphically, the extra quantity order decisions lead to be lower than the optimal solution in this conditions. Nevertheless, it is needed a statistical study to have comprehensive conclusions.

For the Low Profit and Low Security Cost, the Chinese results are the following:

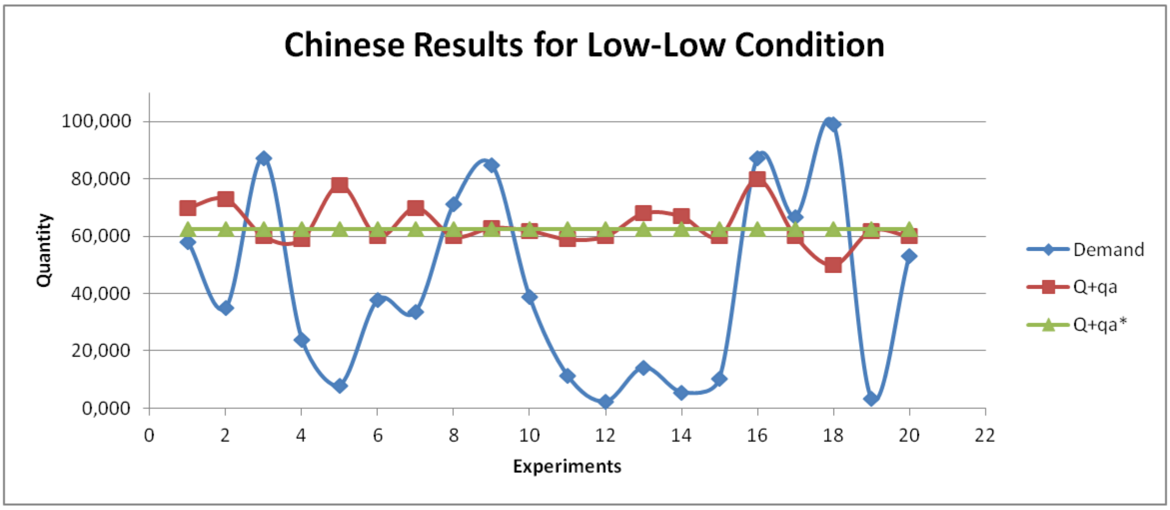


Figure 15 - Dispersion Graph of Chinese results for Low-Low conditions

As we can see graphically, the extra quantity order decisions lead to be similar than the optimal solution in this conditions. Nevertheless, it is needed a statistical study to have comprehensive conclusions.

11.5 Final decision

This experiment has been done by the subjects with the demand uncertainty, this implicates that the final decision of purchasing the extra quantity is not already done. The purchase decision must be done in the stage 2 of the planning season, when the demand is already defined.

This decision will be taken from the point of view of profitable business, which is always to maximize the final profit. In this way, for each experiment done, the final profit will be calculated for both cases, whether purchasing the extra quantity order decision or not. We will use this method because sometimes, even if the demand is higher than the base quantity, is not worth it to purchase an extra quantity, depending on the profit conditions and the security deposit level.

On the one hand, the case that $D < Q$ it is sure that the extra quantity order will be rejected because the storage cost will increase, and therefore the final benefit will be reduced.

On the other hand, we can have the case: $Q + q_a > D > Q$. This situation is where we must compare the final profit with both decisions, purchasing or not the extra quantity order. Depending on the profit conditions, security deposit level and the difference $(Q + q_a - D)$ will be worth it or not.

Knowing that:

$$\boxed{Real\ Profit = r \cdot min(D, Q + q_a) - s \cdot max(0, Q + q_a - D) - p \cdot (Q + q_a) - m - t \cdot I}$$

We will have 4 different cases, and 2 possible profits for each:

(1) High profit condition - High security level:

$$Profit = 9 \cdot min(D, 50 + q_a) - 1 \cdot max(0, 50 + q_a - D) - 3 \cdot (50 + q_a) - 50 - 10 \cdot 2$$

$$Profit_{(q_a=0)} = 9 \cdot min(D, 50 + q_a) - 1 \cdot max(0, 50 + q_a - D) - 3 \cdot (50 + q_a) - 50 - 10$$

(2) High profit condition - Low security level:

$$Profit = 9 \cdot min(D, 50 + q_a) - 1 \cdot max(0, 50 + q_a - D) - 3 \cdot (50 + q_a) - 20 - 10 \cdot 2$$

$$Profit_{(q_a=0)} = 9 \cdot min(D, 50 + q_a) - 1 \cdot max(0, 50 + q_a - D) - 3 \cdot (50 + q_a) - 20 - 10$$

(3) Low profit condition - High security level:

$$Profit = 9 \cdot min(D, 50 + q_a) - 1 \cdot max(0, 50 + q_a - D) - 6 \cdot (50 + q_a) - 50 - 10 \cdot 2$$

$$Profit_{(q_a=0)} = 9 \cdot min(D, 50 + q_a) - 1 \cdot max(0, 50 + q_a - D) - 6 \cdot (50 + q_a) - 50 - 10$$

(4) Low profit condition - Low security level:

$$Profit = 9 \cdot min(D, 50 + q_a) - 1 \cdot max(0, 50 + q_a - D) - 6 \cdot (50 + q_a) - 20 - 10 \cdot 2$$

$$Profit_{(q_a=0)} = 9 \cdot min(D, 50 + q_a) - 1 \cdot max(0, 50 + q_a - D) - 6 \cdot (50 + q_a) - 20 - 10$$

The higher profit will define if it is worth it to purchase the extra quantity or not. Find attached in the Annex D, the graphic with the differences between the profits of each experiment.

From the 160 done in total, the final decision has been to not purchase the extra quantity order in 95 cases and to purchase it in the remaining 65.

Find attached in the Annex E the tables with the profits before and after the decision.

It should be mentioned that this final results are also conditioned by the value that the subjects have given for the extra quantity order. As in some cases, if their extra quantity order decision would had been lower, probably the final profit would be higher than if we do not purchase nothing extra.

However, we assume this cases as isolated because the need of the experimentation with a total demand uncertainty, and the final profit it's calculated with an already defined demand.

12 Analysis

12.1 Statistic background

In this chapter we will compare the samples of the 4 levels experimentation with all the variables chosen. Our main goal is to analyze the differences between group averages and their associated variation between and within them.

The analysis of variance (ANOVA) is especially useful when applied to complex situations because it allows us, by a single test and single risk, answering questions as: The data set of hypothetical populations are different from one another? Are these significant differences?

There are 3 requirements to use ANOVA:

1. Independence of observations

2. Normality: the distributions of the residuals are normal.

3. Homoscedasticity: The variance data in groups should be the same.

In our experimental case, the three requirements are met, therefore, it will be used the Analysis of Variance (ANOVA) which provides a statistical test of whether or not the means of several groups are equal. The hypothesis used are the following:

$$H_0: \mu_1 = \mu_2 = \ \dots \ = \ \mu_i$$

$$H_A = Otherwise$$

The test procedure that is used is based on checking the variance of all data without regard to their cause. The total variance between the proven and experimental error factor is divided. The two variances are compared by a F-test, of Single Factor ANOVA, which is a frequency distribution that helps us to decide whether two processes have no such variability.

The analysis of variance is based on the decomposition of the total variability in two parts. One part due to the variability between different populations or treatments (variability between groups) and another part which can be regarded as variability intrinsic observations (variability within groups).

$$SS = SS_B + SS_W$$

The variability between groups measures the discrepancy between the groups and the global average, so if there are no differences between them (the null hypothesis is true) obtain small variability. If, however, the null hypothesis is false, it is expected that the variability between groups is large.

$$SS_B = \sum_{i=1}^{r} n_i \cdot (\overline{x_\iota} - \bar{x})^2$$

The variability within groups measures the intrinsic variability of observations, that is, if the experiment is well designed and there are not included factors of variation different as the studied, should be purely random error occurred as a result of biological variability of the experimental material.

$$SS_W = \sum_{i=1}^{r} \sum_{j=1}^{n_i} (x_{ij} - \overline{x_\iota})^2$$

The contrast analysis of variance is based on the comparison of variability between and within. We will always reject the null hypothesis if the variability between is great, but using as a comparison pattern the variability within. That is, we will accept a treatment effect provided that they produce greater differences in experimental units than would have without the application thereof.

Before we compare the sums of squares we have to divide them by their respective degrees of freedom related to the number of observations with which the calculation is made. Thus we obtain the mean squares estimators or variability estimators.

The complete information is summarized in the following table, It is what is known as ANOVA table and it resumes all the information necessary to make the corresponding contrast:

ANOVA

Source of Variation	***SS***	***df***	***MS***	***F***
Between Groups	$SS_B = \sum_{i=1}^{r} n_i \cdot (\overline{x_\iota} - \bar{x})^2$	*r-1*	${MS_B}^2 = \frac{SS_B}{r-1}$	$F = \frac{{MS_B}^2}{{MS_W}^2}$
Within Groups	$SS_W = \sum_{i=1}^{r} \sum_{j=1}^{n_i} (x_{ij} - \overline{x_\iota})^2$	*n-r*	${MS_W}^2 = \frac{SS_W}{n-r}$	
Total	$SS = \sum_{i=1}^{r} \sum_{j=1}^{n_i} (x_{ij} - \bar{x})^2$	*n-1*		

Figure 16 - ANOVA table

Where:

r is the number of experimental treatments.

n_i is the sample size of each treatment.

x_{ij} is the observation *j* for the experimental group *i.*

$\overline{x_i}$ is the average of the group samples.

$\bar{x}$ is the average of all the observations.

The hypothesis which is tested in this model is that the population mean are equal. If the averages result equal, it means that the groups are not different in the variables studied.

The strategy to try out the hypothesis of equal averages consists in obtain a statistic F, which reflects the degree of similarity between the averages being compared.

The numerator of the statistic F it's an estimation of the population variance based in the existing variances between the averages of the groups. The denominator it's also a population variance estimation, but it is based in the existing variance within groups.

If the population means are equal, then the samples means will be similar, existing only differences due to chance. In this case, the statistic F will take a lower value than the critical F statistic.

If the F value is higher than the critical F value, then the population means will be different, and the sample means too. So there's a statistically significant effect on the test results.

12.2 Decision analysis of the levels combination

Firstly, we will analyze the relationship between the decisions taken with the different combination of variable levels we have worked with. What we want to see is if really levels have influenced or have had effect in the subjects decisions.

In our particular case, we will analyze the results for the 40 subjects in the 4 levels of the experiment done. The levels are:

Security Level	High	50$ of security cost
	Low	20$ of security cost
Profit Level	High	6$ of profit
	Low	2$ of profit

Table 13 - Level combinations

We will study the combination of the 4 levels above as: High - High, High - Low, Low-High and Low-Low. The null hypothesis we have is the averages to be equal.

The general results are the following:

RESUME

Groups	*Count*	*Sum*	*Average*	*Variance*	*Std. Dev*
High-High	40	1205	30,125	50,72756	7,12233
High-Low	40	385	9,625	47,83013	6,91593
Low-High	40	1684	42,1	30,29744	5,50431
Low-Low	40	562	14,05	95,79231	9,78735

Table 14 - General results for the comparison between the 4 levels combination

And the ANOVA results for single factor are the following:

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	26830,65	3	8943,55	159,246	2,85022E-47	2,66257
Within Groups	8761,25	156	56,1619			
Total	35591,9	159				

Table 15 - ANOVA results for the comparison between the 4 levels combination

As we can see:

$$F = 159{,}246 > Fcrit = 2{,}66257$$

This means that we have statistically significant results that the averages of the 4 levels are different.

Extrapolating these facts to our case, this means that the decisions taken for the Extra Quantity Order are different in each level given. Therefore, we can say that our subjects have made their decisions based on the given levels. So that the levels have influence in the decisions taken.

Therefore, the design of the experiment can be considered as successful, as the subjects have decided according to the conditions given.

12.2.1 Extra Quantity Decision Order - Profit level fixed

Now we will conduct the same test but fixing one of the variables in order to see the significance to the levels of the other one. This will help us to see if there is a relationship between the decisions and the two levels of the security cost.

Fixing the High Profit Condition, the general results are the following:

RESUME

Groups	*Count*	*Sum*	*Average*	*Variance*
High Security Cost	40	1205	30,125	50,7275641
Low Security Cost	40	1684	42,1	30,2974359

Table 16 - General results for the fixed High Profit Condition

And the ANOVA results are the following:

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	2868,013	1	2868,0125	70,79327	1,48233E-12	3,9634719
Within Groups	3159,975	78	40,5125			
Total	6027,988	79				

Table 17 - ANOVA results for the fixed High Profit Condition

As we can see:

$$F = 70{,}79327 > Fcrit = 3{,}9634719$$

So, there exist a significant difference in the decisions between the levels of the security cost in the same high profit condition. As we can see in the general results, the average for the decisions in the high level of the security cost is lower than with the low security cost. This is so rational because even if we are in a high profit condition, the subjects are reluctant to reserve more quantity because of the high fix cost to do it and its direct influence to the final profit.

Fixing the Low Profit Condition, the general results are the following:

RESUME

Groups	*Count*	*Sum*	*Average*	*Variance*
High Security Cost	40	385	9,625	47,8301282
Low Security Cost	40	562	14,05	95,7923077

Table 18 - General results for the fixed Low Profit Condition

And the ANOVA results are the following:

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	391,6125	1	391,6125	5,453361	0,0221027	3,9634719
Within Groups	5601,275	78	71,81121795			
Total	5992,888	79				

Table 19 - ANOVA results for the fixed Low Profit Condition

As we can see:

$$F = 5{,}453361 > Fcrit = 3{,}9634719$$

So, there exist a significant difference in the decisions between the levels of the security cost in the same low profit condition. As we can see in the general results, the average for the decisions in the high level of the security cost is lower than with the low security cost. This is also rational because even if we are in a high profit condition, the subjects are reluctant to reserve more quantity because of the high fix cost to do it and its direct influence to the final profit.

The causes of this phenomenon is that retailer's prefer to order much quantity if the security fix cost is lower. This situation is disadvantageous for the supplier, assuming that the retailer is not required to ensure the selection of goods, which means that vendors allow more production capacity, but they get less cash compensation.

12.2.2 Extra Quantity Decision Order - Security Level Fixed

Now we will conduct the same test but fixing one of the variables in order to see the significance to the levels of the other one. This will help us to see if there is a relationship between the decisions and the two profit levels.

Fixing the High Security Cost, the general results are the following:

RESUME

Groups	*Count*	*Sum*	*Average*	*Variance*
High Profit	40	1205	30,125	50,7275641
Low Profit	40	385	9,625	47,8301282

Table 20 - General results for the fixed High Security level

And the ANOVA results are the following:

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	8405	1	8405	170,56	2,53E-21	3,9634719
Within Groups	3843,75	78	49,278			
Total	12248,75	79				

Table 21 - ANOVA results for the fixed High Security level

As we can see:

$$F = 170{,}56 > Fcrit = 3{,}9634719$$

So, there exist a significant difference in the decisions between the profit in the same high security cost condition. As we can see in the general results, the average for the decisions in the high profit condition is higher than in the low profit condition. This means that through the same situation of security cost, retailer's prefer to order more quantity in a high profit condition. This decision is quite rational because of the possibility of obtain a greater final benefit.

Fixing the Low Security Cost, the general results are the following:

RESUME

Groups	*Count*	*Sum*	*Average*	*Variance*
High Profit	40	1684	42,1	30,2974359
Low Profit	40	562	14,05	95,7923077

Table 22 - General results for the fixed Low Security level

And the ANOVA results are the following:

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	15736,05	1	15736,05	249,6007	5,07115E-26	3,9634719
Within Groups	4917,5	78	63,04487179			
Total	20653,55	79				

Table 23 - ANOVA results for the fixed Low Security level

As we can see:

$$F = 249{,}6007 > Fcrit = 3{,}9634719$$

So, there exist a significant difference in the decisions between the profit in the same low security cost condition. As we can see in the general results, the average for the decisions in the high profit condition is higher than in the low profit condition. This means that through the same situation of security cost, retailer's prefer to order more quantity in a high profit condition. This decision is quite rational because of the possibility of obtain a greater final benefit.

12.2 Comparison between the real quantity decision and the optimal

Now, we will test the averages between the real decisions about the extra quantity order and the optimal extra quantity given by our mathematical model. This is one of our key analysis, the comparison between the real values and the theoretical ones.

We will analyze this comparison through the 4 level combinations for depth study.

Level Combination	*Count*	*Sum*	*Average*	*Variance*
High-High	40	1205	30,125	50,7276
Optimal	40	1500	37,5	0
High - Low	40	385	9,625	47,8301
Optimal	40	500	12,5	0
Low-High	40	1684	42,1	30,2974
Optimal	40	1500	37,5	0
Low-Low	40	562	14,05	95,7923
Optimal	40	500	12,5	0

Table 24 - General results for the comparison between qa and qa*

The results of the ANOVA testing are the following:

ANOVA

Level Combination	*Source of Variation*	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
High Profit High Security Cost	Between Groups	1087,812	1	1087,812	42,88841	5,61E-09	3,963471
	Within Groups	1978,375	78	25,36378			
	Total	3066,187	79				
High Profit Low Security Cost	Between Groups	165,312	1	165,312	6,912484	0,010306	3,963471
	Within Groups	1865,375	78	23,91506			
	Total	2030,687	79				
Low Profit High Security Cost	Between Groups	423,2	1	423,2	27,93635	1,11E-06	3,963471
	Within Groups	1181,6	78	15,14871			
	Total	1604,8	79				
Low Profit Low Security Cost	Between Groups	48,05	1	48,05	1,003212	0,319632	3,963471
	Within Groups	3735,9	78	47,89615			
	Total	3783,95	79				

Table 25 - ANOVA results for the comparison between qa and qa*

12.2.1 High Profit - High Security Cost

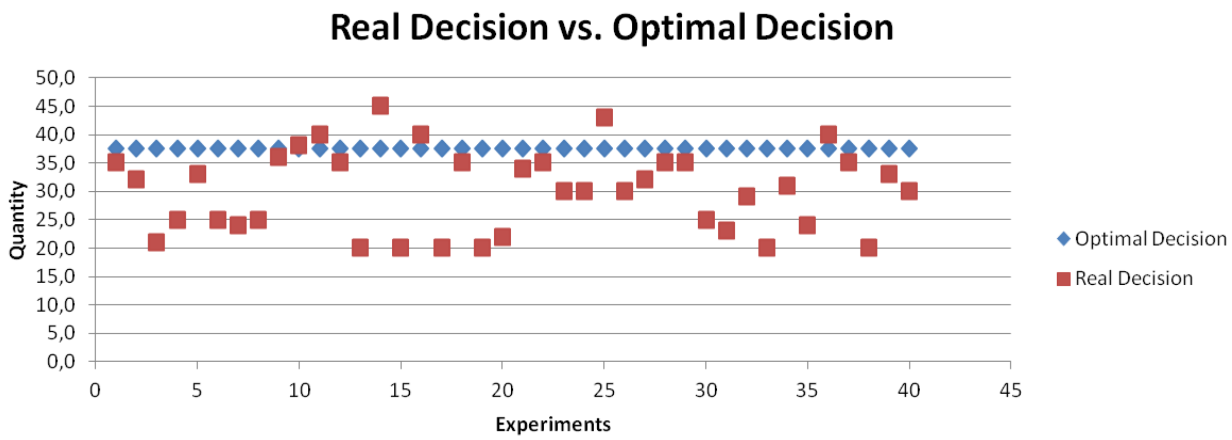


Figure 17 - Comparison between qa and qa* for High-High combination

The average for the real decisions is $\overline{q_a} = 30{,}125 < \; q_a^* = 37{,}5$.

The result for the ANOVA test is $F = 42{,}888 > Fcrit = 3{,}96$. Based in this facts, this means that the real decisions are significantly lower than the theoretical optimal value.

12.2.2 High Profit - Low Security Cost

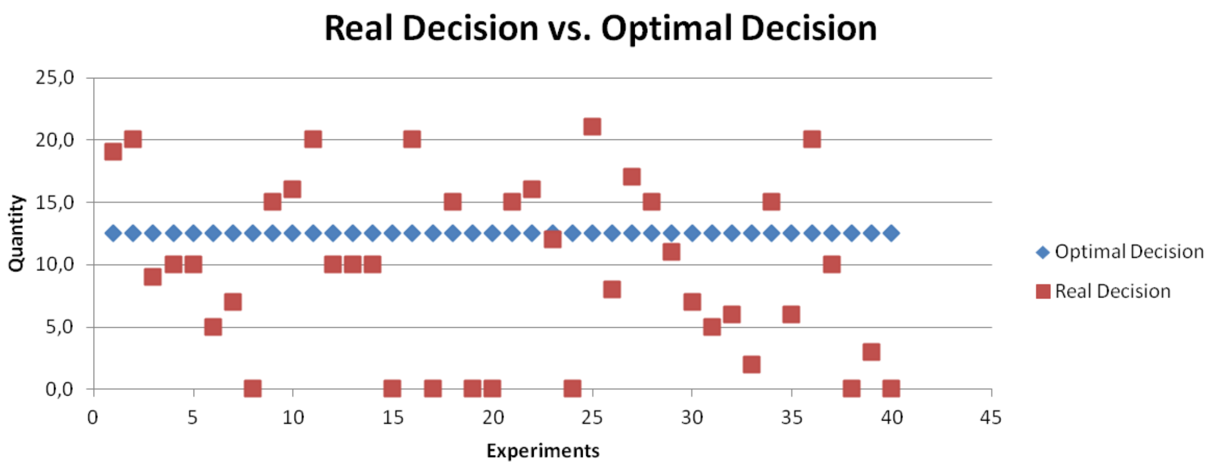


Figure 18 - Comparison between qa and qa* for High-Low combination

The average for the real decisions is $\overline{q_a} = 9{,}625 < \; q_a^* = 12{,}5$.

The result for the ANOVA test is $F = 6{,}912484 > Fcrit = 3{,}963472$. Based in this facts, this means that the real decisions are significantly lower than the theoretical optimal value.

12.2.3 Low Profit - High Security Cost

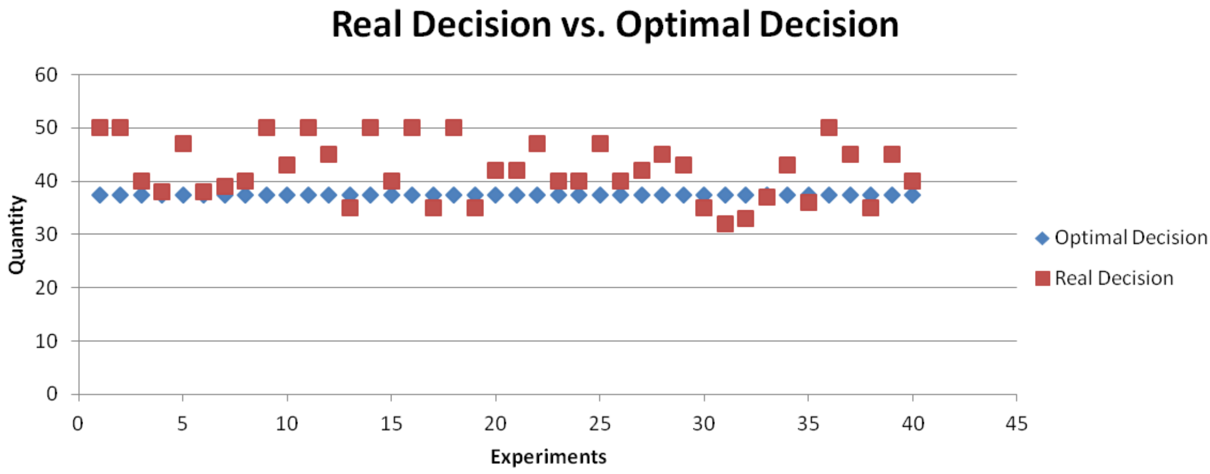


Figure 19 - Comparison between qa and qa* for Low-High combination

The average for the real decisions is $\overline{q_a} = 42{,}1 > q_a^* = 37{,}5$.

The result for the ANOVA test is $F = 27{,}93636 > Fcrit = 3{,}963472$. Based in this facts, this means that the real decisions are significantly higher than the theoretical optimal value.

12.2.4 Low Profit - Low Security Cost

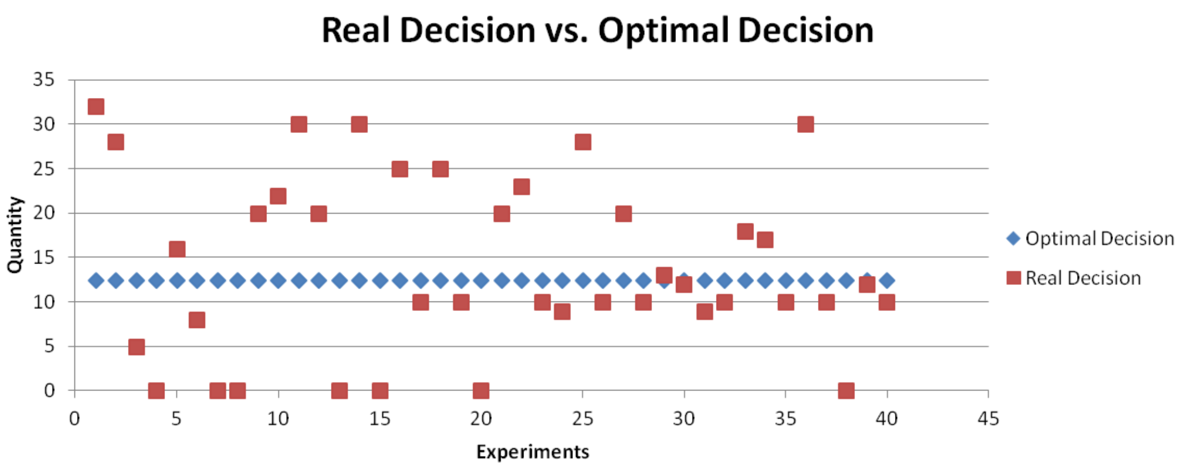


Figure 20 - Comparison between qa and qa* for Low-Low combination

The average for the real decisions is $\overline{q_a} = 14{,}05 > q_a^* = 12{,}5$.

The result for the ANOVA test is $F = 1{,}003212 > Fcrit = 3{,}963472$. Based in this facts, this means that we cannot reject the null hypothesis of the means to be equal. Therefore, there are not significantly differences between the real and optimal averages in this level combination.

As a resumed analysis, we can see that there are significant differences between the real decisions and the optimal results.

The real values decisions for the high profit condition are significantly higher than the optimal theoretical value. However, for the low profit condition, the real value decisions are significantly lower than the optimal theoretical value or there are not significantly differences.

Therefore, the conclusions we can draw are that for the retailer, in a high profit condition, the expectation of having a greater final profit leads them to decide a higher quantity order. In fact, this is not a entirely rational decision, because of the potential risk of inventory accumulation whence a higher inventory cost which makes the final profit to be lower than expected.

In the low profit condition, the retailers make more conservative decisions than the optimal ones because of the thinking of not being a worth business. In fact, this is not the most rational decision, because even if the profit is low, there are fix costs as the ordering cost or the security cost that might be covered.

The psychology of the decisions taken in Supply Chain management is complex and uncertain. It's difficult to lead with all the conditions with the uncertainty of demands, in the real world it's almost impossible to approach for the optimal levels. Nevertheless, it is needed to work hard with the information, planning and forecast updating which are key points to get the best possible results.

12.3 Effect of different nationalities

Now, we will make the comparison between both nationalities tested, Spanish and Chinese. We will compare their decisions trying to get if there are differences between the subjects thinking and if it is related to their original countries.

RESUME

Groups	*Count*	*Sum*	*Average*	*Variance*
Spanish	80	1935	24,1875	250,204905
Chinese	80	1901	23,7625	200,234019

Table 26 - General results for the comparison between nationalities

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	7,225	1	7,225	0,032079	0,858082	3,900988
Within Groups	35584,675	158	225,2194			
Total	35591,9	159				

Table 27 - ANOVA results for the comparison between nationalities

As we can see:

$$F = 0{,}032079 < Fcrit = 3{,}900988$$

Therefore, we cannot reject the null hypothesis for the averages to be equal. So there is not a significantly differences between the decision making of the Spanish subjects and the Chinese subjects.

All the testers did the experiment in the same conditions with the same environment and description. So we can conclude that even with the cultural differences and living habits there is not a significant difference in the decision making of this experiment.

Nevertheless, we cannot forget that this experiment has been developed with only 20 subjects of these country. even if each subject did 4 experiments, the sample it's maybe too small to have robust conclusions regarding the differences in the decision making.

Also, we have to say that the subjects are all students of Beihang University, with very similar profiles of knowledge. This can also be a factor that they are not significantly different.

12.4 Effect of the subject's risk appetite

Now, we will analyze the relationship between the decisions taken with the subject's risk appetite that we have already defined in the Chapter 5.

The general results for the test are the following:

RESUME

Groups	*Count*	*Sum*	*Average*	*Variance*
High Risk	60	1852	30,86667	176,01582
Medium Risk	28	683	24,39286	183,50661
High Safe	72	1301	18,06944	209,67117

Table 28 - General results for the comparison between risk appetites

The ANOVA results for the test are the following:

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	5365,6353	2	2682,8177	13,93498	2,6861E-06	3,053628
Within Groups	30226,2647	157	192,5240			
Total	35591,9	159				

Table 29 - ANOVA results for the comparison between risk appetites

As we can see:

$$F = 13{,}93498 > Fcrit = 3{,}053628$$

Therefore, the risk appetite has a significantly impact on the decision making of subjects. The high risk behavior has the higher average, as the risky people tends to order a greater quantity order. Their behavior makes them assume a potential risk which usually result in a clear loss of ultimate benefit.

In fact, we can say that is a success to have this results. The method of classification of risk appetite has given results which are directly related to the experiment decisions.

12.5 Comparison between real profit and optimal profit

In this section we will analyze the relation between the real profit obtained with the subject's decisions and the optimal profit obtained by the mathematical model.

RESUME

Groups	*Count*	*Sum*	*Average*	*Variance*
Real Profit	160	10164,3524	63,52720	52590,79499
Optimal Profit	160	81320	508,25000	77339,37107

Table 30 - General results for the comparison between real and optimal profit

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*
Between Groups	15822269,33	1	15822269,334	243,550	3,657E-41	3,87086
Within Groups	20658896,40	318	64965,083			
Total	36481165,74	319				

Table 31 - ANOVA results for the comparison between real and optimal profit

As we can see:

$$F = 243.55 > Fcrit = 3.87086$$

Therefore, there exist a significantly difference between the averages of the real profit obtained in the experiment and the optimal profit obtained by the mathematical model. In fact, the optimal profit average is so much greater than the real one obtained.

The reason for this is that the optimal solution always guarantee the maximum benefit possible in every case. However, the optimal conditions have to be considered as ideal, and even if they are impossible to reach, we must work hard for our results to resemble the optimal solution.

13 Conclusions

The Supply Chain Management is a field with a great extension of theory development, due to the high dependence of this field in the business flows between companies nowadays.

Flexible quantity contracts have been also researched from a theoretical point of view, however, they are still unexplored in an experimental research way.

In a specific market environment, the mathematical models for this contract are developed, focused on the global optimum quantity order accomplishing the flexibility restrictions and maximizing the global profit margins throughout the supply chain.

Nevertheless, the real environment sustain factors and human behaviors which are far from optimal results. And is in this point where this thesis have been focused. The order quantity with the flexibility option allows the retailers to react faster to the fluctuations in the demand market and to reduce the risk taken in the business process. However, from the standpoint of the supplier, the reserve of production capacity to introduce this flexibility in the process carries a risk that must be compensated by a security deposit in the event that finally the sale is not carried out.

Different retailers have different degrees of risk preferences, and this causes deviation between the quantity order decisions from the theoretical optimal values. As well as the risk appetite, the factors of profit levels and security deposit levels have also effect in the decision making. Therefore, this thesis studies the relationship between these three factors and their affectation to the decision making.

To achieve the main objectives, four experiments were designed, with the combination of two variables levels, high profit, low profit, high security cost and low security cost. It was tested in four market situations to ensure that the enough number of decisions were made in order to have robust conclusions.

With the statistical analysis by organizational experiments and experimental data, we can summarize the following conclusions:

1. The decision making from subjects with limited rationality, is not in full conformity with the order of the optimal values.

2. The risky behavior clearly affects the return results of decisions, whose values are above to the optimal ones. And their decisions order are also higher than the conservative subjects. Therefore, the risk appetite is a significant factor in the experiment, and it is a point to take care and make further research trying to stop the influence in the decisions and therefore in the business.

3. The high profit condition groups were significantly higher than the theoretical optimal results, however, the low profit condition groups were significantly lower than the optimal value or with not significant differences.

4. With the high profit condition, we can see that even with the high security cost or low security cost, the quantity decisions are significantly higher than in the low profit condition. So the profit level has a clear effect in the decision making.

5. In order to avoid disadvantages, the retailers benefit expectations level of the product is the main factor in the decision making. However, the excessive pursuit of high profits and low risks will lead to miss profit maximum points.

During the research process has found the following deficiencies:

Firstly a research about the market information was done, but it may not match the actual situation of the microchip sector.

In second place, in order to facilitate the experiment design, several hypothesis were taken to simplify some situations and the subsequent analysis. For instance, in the actual environment, for retailers it is impossible to accurately know the market demand and adjust ordering decisions.

In third place, we cannot forget our inadequate sample size. To have completely reliable statistical studies it is needed to have a large sample size to resemble the population and get robust conclusions. Nonetheless, the experiment results have been significant enough for considering the goals reached.

In conclusion, we can say that the risk appetite is a factor which is present in our environment and it is need to be aware of it and its consequences. In the Supply Chain Management the risky behavior has no place because it leads to risky situations that endanger the business processes and the final benefit of all parties.

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15 Acknowledgements

I would like to express my sincere gratitude for my supervisor Prof. Wang He Xin for his continuous support on my research, for his motivation and engagement through the learning process of this final thesis. Furthermore I would like to thank my research mates, specially Shi Xiaoqian, in the experiments carried out, without which the development of the research would not have been possible.

My sincere thanks for Beihang University, for giving me the opportunity of doing my final thesis here. And also thanks for UPC for the strong study background that I've earned during the last 5 years.

At last but not the least, I would like to thank my family for making possible my exchange here. They are who have supported me throughout the entire process and throughout my life.

16 ANNEX

A

1					2				
0.5	0.3	0.2	0.0	0.0	0.0	0.0	0.2	0.8	0.5
0.0	0.0	0.2	0.3	0.5	0.2	0.3	0.3	0.2	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.8	0.0
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.5	0.0
0.5	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.8	0.5
0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.8	0.0
0.0	0.2	0.3	0.3	0.2	0.0	0.2	0.3	0.5	0.0
0.8	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2	0.5
0.0	0.0	0.2	0.3	0.5	0.3	0.2	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	0.0
3					**4**				
0.0	0.0	0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2
2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0
0.3	0.2	0.0	0.0	0.0	0.0	0.2	0.8	0.0	0.2
0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.8	0.0	0.0
0.0	0.2	0.3	0.5	0.0	0.2	0.3	0.5	0.0	0.0
0.3	0.2	0.0	0.0	0.0	0.0	0.2	0.8	0.0	0.0
0.0	0.2	0.3	0.5	0.0	0.2	0.3	0.5	0.8	0.2
0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.5	0.0	0.0
0.2	0.3	0.3	0.2	0.0	0.0	0.2	0.8	0.0	0.2
5					**6**				
0.3	0.2	0.0	0.0	0.2	3.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.2	0.3	0.2	0.3	0.5	0.0	0.2
0.3	0.5	0.0	0.0	0.2	0.0	0.2	0.8	0.0	0.2
0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.5	0.0	0.0
3.0	0.0	0.0	0.0	0.0	0.2	0.3	0.5	0.0	0.0

0.2	0.3	0.5	0.0	0.2	0.2	0.3	0.5	0.8	0.2
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0.2	0.3	0.5	0.0	0.0	0.0	0.2	0.8	0.5	0.3
0.2	0.3	0.5	0.8	0.2	0.2	0.0	0.0	0.5	0.3
7					**8**				
0.0	0.0	0.0	0.0	0.2	0.0	0.5	0.3	0.2	0.0
0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.2	0.3
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0
0.0	0.0	0.0	0.0	0.0	0.2	0.8	0.0	0.2	0.3
0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.0	0.0	0.2
0.0	0.0	0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2
0.0	0.0	0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2
0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.2	0.3
0.0	0.0	0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2
9					**10**				
0.0	0.0	0.2	0.3	0.3	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.0	0.2	0.3	0.5	0.3	0.2	0.0	0.0
0.0	0.8	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.0	0.2	0.3	0.8	0.2	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.2	0.3	0.0	0.0	0.0	10.0	0.0
0.0	0.0	0.5	0.3	0.2	0.2	0.5	0.3	0.2	0.0
0.0	0.0	0.0	0.0	0.2	0.0	0.5	0.3	0.2	0.0
0.0	0.0	0.0	0.0	0.2	0.5	0.0	0.0	0.0	0.2
11					**12**				
0.5	0.3	0.2	0.0	0.0	0.5	0.3	0.2	0.0	0.0
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2

0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.0	0.0
0.5	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.0	0.0
0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.0	0.0	0.0
0.5	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.0	0.0
13					**14**				
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15					**16**				
0.0	0.0	0.0	0.0	0.0	0	0	0.2	0.3	0.5
0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.2	0	0
0.0	0.0	0.0	0.0	0.0	0	0	0.2	0.3	0.5
0.0	0.0	0.0	0.0	0.0	0	0	0.2	0.3	0.5
0.0	0.0	0.0	0.0	0.0	0.8	0.2	0	0	0
0.0	0.0	0.0	0.0	0.0	0	0	0.2	0.3	0.5
0.0	0.0	0.0	0.0	0.0	0	0.2	0.3	0.3	0.2
0.0	0.0	0.0	0.0	0.0	0	0.2	0.3	0.3	0.2
0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.2	0	0
0.0	0.0	0.0	0.0	0.0	0	0	0.2	0.3	0.5

17					**18**				
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.0	0.2	0.8	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.2	0.3	0.3	0.2
0.0	0.2	0.3	0.3	0.2	0.0	0.2	0.3	0.3	0.2
0.0	0.2	0.3	0.3	0.2	0.8	0.2	0.0	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.2	0.8
19					**20**				
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.2	0.3	0.3	0.2	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.0	0.2	0.8
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.2	0.3	0.3	0.2	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.2	0.3	0.5
0.5	0.3	0.2	0.0	0.0	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.0	0.2	0.8	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
21					**22**				
0.0	0.2	0.3	0.3	0.2	0.0	0.2	0.3	0.3	0.2
0.0	0.2	0.3	0.3	0.2	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.2	0.3	0.3	0.2	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.5	0.3	0.2	0.0	0.0	0.5	0.3	0.2	0.0	0.0

0.0	0.2	0.3	0.3	0.2	0.5	0.3	0.2	0.0	0.0
0.8	0.2	0.0	0.0	0.0	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
23					**24**				
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2
0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.0	0.2	0.8
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.0	0.2	0.8
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.2	0.8
0.5	0.3	0.2	0.0	0.0	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.2	0.3	0.3	0.2	0.0	0.2	0.3	0.3	0.2
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2
0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
25					**26**				
0.5	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.8
0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.0	0.2	0.8
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.2	0.3	0.3	0.2	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.0	0.2	0.8
0.5	0.3	0.2	0.0	0.0	0.5	0.3	0.2	0.0	0.0
0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.0	0.2	0.8
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
27					**28**				
0.0	0.2	0.3	0.3	0.2	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5

0.5	0.3	0.2	0.0	0.0	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.2	0.3	0.5
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2
0.0	0.2	0.3	0.3	0.2	0.8	0.2	0.0	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
29					**30**				
0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.0	0.2	0.8
0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.2	0.8
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.2	0.8
0.5	0.3	0.2	0.0	0.0	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.0	0.2	0.8
0.5	0.3	0.2	0.0	0.0	0.0	0.0	0.2	0.3	0.5
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2
0.5	0.3	0.2	0.0	0.0	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.2	0.8
31					**32**				
0.0	0.0	0.0	0.2	0.8	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.0	0.2	0.8	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.5	0.3	0.2	0.0	0.0	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2
0.0	0.2	0.3	0.3	0.2	0.5	0.3	0.2	0.0	0.0
0.0	0.2	0.3	0.3	0.2	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
33					**34**				
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2

0.0	0.0	0.2	0.3	0.5	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.2	0.3	0.3	0.2	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.5	0.3	0.2	0.0	0.0	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
35					**36**				
0.0	0.0	0.0	0.2	0.8	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.2	0.3	0.3	0.2	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.2	0.3	0.3	0.2	0.8	0.2	0.0	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.2	0.3	0.5	0.8	0.2	0.0	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
37					**38**				
0.0	0.2	0.3	0.3	0.2	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.0	0.2	0.8
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
0.0	0.2	0.3	0.3	0.2	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.0	0.2	0.8
0.0	0.2	0.3	0.3	0.2	0.0	0.2	0.3	0.3	0.2
0.5	0.3	0.2	0.0	0.0	0.0	0.0	0.2	0.3	0.5
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5

0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5
39					**40**				
0.5	0.3	0.2	0.0	0.0	0.5	0.3	0.2	0.0	0.0
0.0	0.0	0.0	0.2	0.8	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.2	0.8
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.2	0.8
0.0	0.2	0.3	0.3	0.2	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.2	0.8
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2
0.5	0.3	0.2	0.0	0.0	0.0	0.2	0.3	0.3	0.2
0.0	0.0	0.2	0.3	0.5	0.0	0.0	0.2	0.3	0.5

B

Subjects	Experiments	qa	Security Cost Level	Profit Level
1	1	35	high	high
	2	19	high	low
	3	50	low	high
	4	32	low	low
2	5	32	high	high
	6	20	high	low
	7	50	low	high
	8	28	low	low
3	9	21	high	high
	10	9	high	low
	11	40	low	high
	12	5	low	low
4	13	25	high	high
	14	10	high	low
	15	38	low	high
	16	0	low	low
5	17	33	high	high
	18	10	high	low
	19	47	low	high
	20	16	low	low
6	21	25	high	high
	22	5	high	low
	23	38	low	high
	24	8	low	low
7	25	24	high	high
	26	7	high	low
	27	39	low	high
	28	0	low	low
8	29	25	high	high
	30	0	high	low
	31	40	low	high
	32	0	low	low
9	33	36	high	high
	34	15	high	low
	35	50	low	high
	36	20	low	low
10	37	38	high	high
	38	16	high	low
	39	43	low	high
	40	22	low	low

Table 32 - Spanish Extra Quantity Order decision

Subjects	Experiments	qa	Security Cost Level	Profit Level
11	41	40	high	high
	42	20	high	low
	43	50	low	high
	44	30	low	low
12	45	35	high	high
	46	10	high	low
	47	45	low	high
	48	20	low	low
13	49	20	high	high
	50	10	high	low
	51	35	low	high
	52	0	low	low
14	53	45	high	high
	54	10	high	low
	55	50	low	high
	56	30	low	low
15	57	20	high	high
	58	0	high	low
	59	40	low	high
	60	0	low	low
16	61	40	high	high
	62	20	high	low
	63	50	low	high
	64	25	low	low
17	65	20	high	high
	66	0	high	low
	67	35	low	high
	68	10	low	low
18	69	35	high	high
	70	15	high	low
	71	50	low	high
	72	25	low	low
19	73	20	high	high
	74	0	high	low
	75	35	low	high
	76	10	low	low
20	77	22	high	high
	78	0	high	low
	79	42	low	high
	80	0	low	low

Table 33 - Spanish Extra Quantity Order decision

C

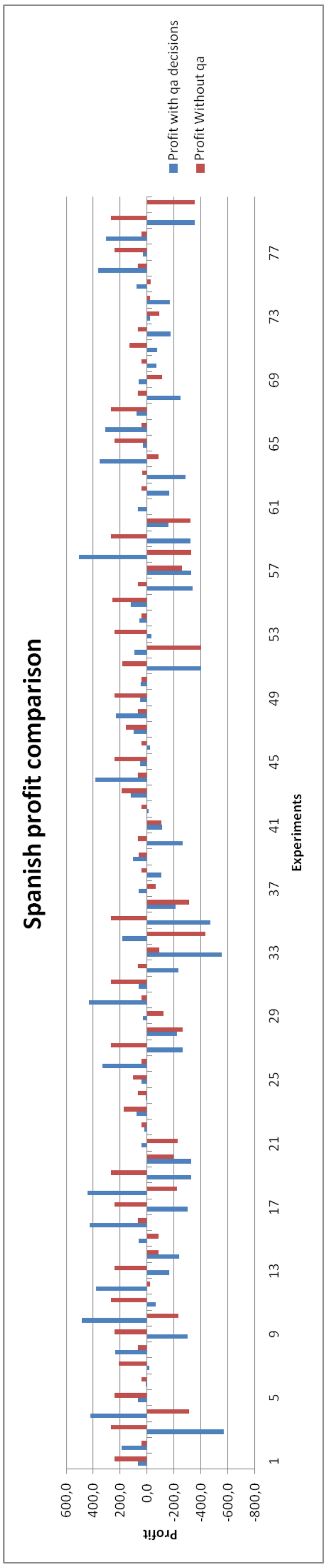
Subjects	Experiments	qa	Security Cost Level	Profit Level
21	81	34	high	high
	82	15	high	low
	83	42	low	high
	84	20	low	low
22	85	35	high	high
	86	16	high	low
	87	47	low	high
	88	23	low	low
23	89	30	high	high
	90	12	high	low
	91	40	low	high
	92	10	low	low
24	93	30	high	high
	94	0	high	low
	95	40	low	high
	96	9	low	low
25	97	43	high	high
	98	21	high	low
	99	47	low	high
	100	28	low	low
26	101	30	high	high
	102	8	high	low
	103	40	low	high
	104	10	low	low
27	105	32	high	high
	106	17	high	low
	107	42	low	high
	108	20	low	low
28	109	35	high	high
	110	15	high	low
	111	45	low	high
	112	10	low	low
29	113	35	high	high
	114	11	high	low
	115	43	low	high
	116	13	low	low
30	117	25	high	high
	118	7	high	low
	119	35	low	high
	120	12	low	low

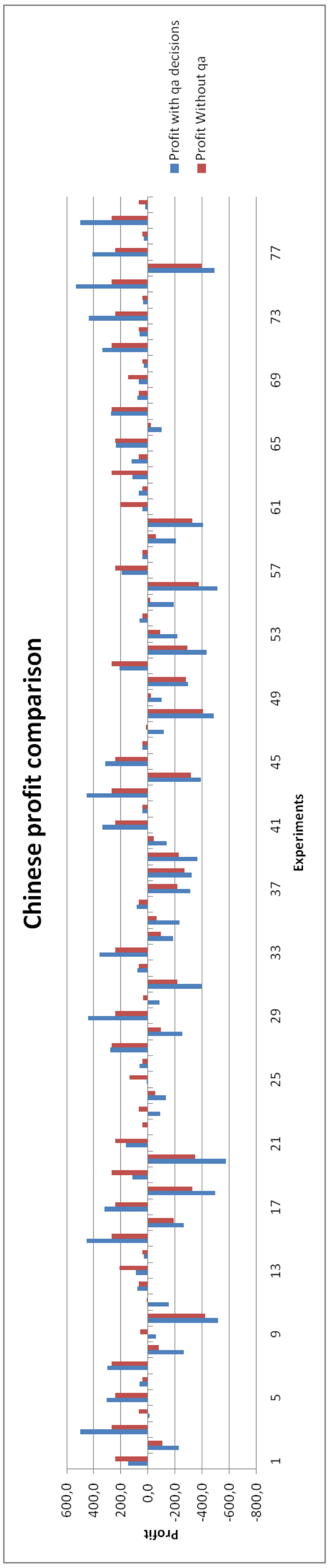
Table 34 - Chinese Extra Quantity Order decision

Subjects	Experiments	qa	Security Cost Level	Profit Level
31	121	23	high	high
	122	5	high	low
	123	32	low	high
	124	9	low	low
32	125	29	high	high
	126	6	high	low
	127	33	low	high
	128	10	low	low
33	129	20	high	high
	130	2	high	low
	131	37	low	high
	132	18	low	low
34	133	31	high	high
	134	15	high	low
	135	43	low	high
	136	17	low	low
35	137	24	high	high
	138	6	high	low
	139	36	low	high
	140	10	low	low
36	141	40	high	high
	142	20	high	low
	143	50	low	high
	144	30	low	low
37	145	35	high	high
	146	10	high	low
	147	45	low	high
	148	10	low	low
38	149	20	high	high
	150	0	high	low
	151	35	low	high
	152	0	low	low
39	153	33	high	high
	154	3	high	low
	155	45	low	high
	156	12	low	low
40	157	30	high	high
	158	0	high	low
	159	40	low	high
	160	10	low	low

Table 35 - Chinese Extra Quantity Order decision

D


Spanish profit comparison
Profit with qa decisions
Profit Without qa
Profit
600,0
400,0
200,0
0,0
-200,0
-400,0
-600,0
-800,0
Experiments
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77


Chinese profit comparison
Profit with qa decisions
Profit Without qa
Profit
600,0
400,0
200,0
0,0
-200,0
-400,0
-600,0
-800,0
Experiments
1
5
9
13
17
21
25
29
33
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Experiments	*Extra Quantity Order [qa]*	*Total Revenue*	*Total cost*	*Total profit*	*Revenue with qa=0*	*Cost with qa=0*	*Profit with qa=0*	*DECISION*	*FINAL PROFIT*
1	35	607,7	332,5	275,2	450,0	210,0	240,0	YES QA	275,2
2	19	621,0	553,0	68,0	450,0	410,0	40,0	YES QA	68,0
3	50	555,3	368,3	187,0	450,0	180,0	270,0	NOT QA	270,0
4	32	106,7	674,1	-567,4	106,7	418,1	-311,4	NOT QA	-311,4
5	32	738,0	316,0	422,0	450,0	210,0	240,0	YES QA	422,0
6	20	630,0	560,0	70,0	450,0	410,0	40,0	YES QA	70,0
7	50	394,9	386,1	8,8	394,9	186,1	208,8	NOT QA	208,8
8	28	576,0	590,0	-14,0	450,0	380,0	70,0	NOT QA	70,0
9	21	521,3	286,1	235,2	450,0	210,0	240,0	NOT QA	240,0
10	9	206,1	509,1	-303,0	206,1	437,1	-231,0	NOT QA	-231,0
11	40	786,7	302,6	484,1	450,0	180,0	270,0	YES QA	484,1
12	5	366,7	429,3	-62,6	366,7	389,3	-22,6	NOT QA	-22,6
13	25	675,0	295,0	380,0	450,0	210,0	240,0	YES QA	380,0
14	10	339,5	502,3	-162,7	339,5	422,3	-82,7	NOT QA	-82,7
15	38	131,3	367,4	-236,1	131,3	215,4	-84,1	NOT QA	-84,1
16	0	450,0	390,0	60,0	450,0	380,0	70,0	NOT QA	70,0
17	33	747,0	319,0	428,0	450,0	210,0	240,0	YES QA	428,0
18	10	215,8	516,0	-300,2	215,8	436,0	-220,2	NOT QA	-220,2
19	47	773,0	332,1	440,9	450,0	180,0	270,0	YES QA	440,9
20	16	208,8	534,8	-326,0	208,8	406,8	-198,0	NOT QA	-198,0
21	25	29,2	356,8	-327,6	29,2	256,8	-227,6	NOT QA	-227,6
22	5	495,0	455,0	40,0	450,0	410,0	40,0	YES QA	40,0
23	38	361,9	341,8	20,1	361,9	189,8	172,1	NOT QA	172,1
24	8	522,0	446,0	76,0	450,0	380,0	70,0	YES QA	76,0
25	24	328,7	319,5	9,2	328,7	223,5	105,2	NOT QA	105,2
26	7	513,0	469,0	44,0	450,0	410,0	40,0	YES QA	44,0
27	39	644,5	314,4	330,1	450,0	180,0	270,0	YES QA	330,1
28	0	149,1	413,4	-264,4	149,1	413,4	-264,4	YES QA	-264,4
29	25	126,2	346,0	-219,8	126,2	246,0	-119,8	NOT QA	-119,8
30	0	450,0	420,0	30,0	450,0	410,0	40,0	NOT QA	40,0
31	40	740,5	307,7	432,8	450,0	180,0	270,0	YES QA	432,8
32	0	450,0	390,0	60,0	450,0	380,0	70,0	NOT QA	70,0
33	36	152,3	387,1	-234,7	152,3	243,1	-90,7	NOT QA	-90,7
34	15	22,4	577,5	-555,1	22,4	457,5	-435,1	NOT QA	-435,1
35	50	551,5	368,7	182,8	450,0	180,0	270,0	NOT QA	270,0
36	20	106,2	578,2	-472,0	106,2	418,2	-312,0	NOT QA	-312,0
37	38	178,6	392,2	-213,5	178,6	240,2	-61,5	NOT QA	-61,5

38	16	594,0	532,0	62,0	450,0	410,0	40,0	YES QA	62,0
39	43	265,2	372,5	-107,3	265,2	200,5	64,7	NOT QA	64,7
40	22	648,0	544,0	104,0	450,0	380,0	70,0	YES QA	104,0
41	40	138,4	404,6	-266,2	138,4	244,6	-106,2	NOT QA	-106,2
42	20	458,0	569,1	-111,2	450,0	410,0	40,0	NOT QA	40,0
43	50	378,2	388,0	-9,8	378,2	188,0	190,2	NOT QA	190,2
44	30	720,0	600,0	120,0	450,0	380,0	70,0	YES QA	120,0
45	35	705,2	321,6	383,6	450,0	210,0	240,0	YES QA	383,6
46	10	540,0	490,0	50,0	450,0	410,0	40,0	YES QA	50,0
47	45	349,8	371,1	-21,3	349,8	191,1	158,7	NOT QA	158,7
48	20	630,0	530,0	100,0	450,0	380,0	70,0	YES QA	100,0
49	20	513,5	282,9	230,6	450,0	210,0	240,0	NOT QA	240,0
50	10	540,0	490,0	50,0	450,0	410,0	40,0	YES QA	50,0
51	35	373,5	328,5	45,0	373,5	188,5	185,0	NOT QA	185,0
52	0	25,2	427,2	-402,0	25,2	427,2	-402,0	YES QA	-402,0
53	45	482,9	386,3	96,5	450,0	210,0	240,0	NOT QA	240,0
54	10	455,7	489,4	-33,7	450,0	410,0	40,0	NOT QA	40,0
55	50	439,8	381,1	58,7	439,8	181,1	258,7	NOT QA	258,7
56	30	720,0	600,0	120,0	450,0	380,0	70,0	YES QA	120,0
57	20	2,3	339,7	-337,4	2,3	259,7	-257,4	NOT QA	-257,4
58	0	119,8	446,7	-326,9	119,8	446,7	-326,9	YES QA	-326,9
59	40	805,5	300,5	505,0	450,0	180,0	270,0	YES QA	505,0
60	0	94,8	419,5	-324,7	94,8	419,5	-324,7	YES QA	-324,7
61	40	237,2	393,6	-156,5	237,2	233,6	3,5	NOT QA	3,5
62	20	630,0	560,0	70,0	450,0	410,0	40,0	YES QA	70,0
63	50	240,6	403,3	-162,7	240,6	203,3	37,3	NOT QA	37,3
64	25	308,9	595,7	-286,8	308,9	395,7	-86,8	NOT QA	-86,8
65	20	630,0	280,0	350,0	450,0	210,0	240,0	YES QA	350,0
66	0	450,0	420,0	30,0	450,0	410,0	40,0	NOT QA	40,0
67	35	612,2	302,0	310,2	450,0	180,0	270,0	YES QA	310,2
68	10	540,0	460,0	80,0	450,0	380,0	70,0	YES QA	80,0
69	35	134,4	385,1	-250,7	134,4	245,1	-110,7	NOT QA	-110,7
70	15	585,0	525,0	60,0	450,0	410,0	40,0	YES QA	60,0
71	50	322,8	394,1	-71,3	322,8	194,1	128,7	NOT QA	128,7
72	25	498,7	574,6	-75,9	450,0	380,0	70,0	NOT QA	70,0
73	20	151,2	323,2	-172,0	151,2	243,2	-92,0	NOT QA	-92,0
74	0	394,0	416,2	-22,2	394,0	416,2	-22,2	YES QA	-22,2
75	35	181,5	349,8	-168,3	181,5	209,8	-28,3	NOT QA	-28,3
76	10	540,0	460,0	80,0	450,0	380,0	70,0	YES QA	80,0
77	22	648,0	286,0	362,0	450,0	210,0	240,0	YES QA	362,0
78	0	450,0	420,0	30,0	450,0	410,0	40,0	NOT QA	40,0
79	42	633,5	327,6	305,9	450,0	180,0	270,0	YES QA	305,9

80	0	70,9	422,1	-351,2	70,9	422,1	-351,2	YES QA	-351,2
81	34	490,2	341,5	148,6	450,0	210,0	240,0	NOT QA	240,0
82	15	318,5	544,6	-226,1	318,5	424,6	-106,1	NOT QA	-106,1
83	42	809,0	308,1	500,9	450,0	180,0	270,0	YES QA	500,9
84	20	522,8	531,9	-9,1	450,0	380,0	70,0	NOT QA	70,0
85	35	636,1	329,3	306,8	450,0	210,0	240,0	YES QA	306,8
86	16	594,0	532,0	62,0	450,0	410,0	40,0	YES QA	62,0
87	47	646,3	346,2	300,1	450,0	180,0	270,0	YES QA	300,1
88	23	315,3	579,0	-263,6	315,3	395,0	-79,6	NOT QA	-79,6
89	30	287,8	348,0	-60,2	287,8	228,0	59,8	NOT QA	59,8
90	12	32,6	552,4	-519,8	32,6	456,4	-423,8	NOT QA	-423,8
91	40	213,6	366,3	-152,6	213,6	206,3	7,4	NOT QA	7,4
92	10	540,0	460,0	80,0	450,0	380,0	70,0	YES QA	80,0
93	30	421,1	333,2	87,8	421,1	213,2	207,8	NOT QA	207,8
94	0	450,0	420,0	30,0	450,0	410,0	40,0	NOT QA	40,0
95	40	757,8	305,8	452,0	450,0	180,0	270,0	YES QA	452,0
96	9	216,1	478,0	-261,9	216,1	406,0	-189,9	NOT QA	-189,9
97	43	678,5	356,6	321,8	450,0	210,0	240,0	YES QA	321,8
98	21	118,3	614,9	-496,5	118,3	446,9	-328,5	NOT QA	-328,5
99	47	478,4	364,8	113,6	450,0	180,0	270,0	NOT QA	270,0
100	28	71,7	646,0	-574,4	71,7	422,0	-350,4	NOT QA	-350,4
101	30	487,4	325,8	161,6	450,0	210,0	240,0	NOT QA	240,0
102	8	475,8	471,1	4,7	450,0	410,0	40,0	NOT QA	40,0
103	40	267,9	360,2	-92,3	267,9	200,2	67,7	NOT QA	67,7
104	10	339,4	472,3	-132,9	339,4	392,3	-52,9	NOT QA	-52,9
105	32	355,7	348,5	7,2	355,7	220,5	135,2	NOT QA	135,2
106	17	603,0	539,0	64,0	450,0	410,0	40,0	YES QA	64,0
107	42	608,5	330,4	278,2	450,0	180,0	270,0	YES QA	278,2
108	20	302,6	556,4	-253,8	302,6	396,4	-93,8	NOT QA	-93,8
109	35	765,0	325,0	440,0	450,0	210,0	240,0	YES QA	440,0
110	15	447,2	530,3	-83,1	447,2	410,3	36,9	NOT QA	36,9
111	45	10,8	408,8	-398,0	10,8	228,8	-218,0	NOT QA	-218,0
112	10	540,0	460,0	80,0	450,0	380,0	70,0	YES QA	80,0
113	35	682,0	324,2	357,8	450,0	210,0	240,0	YES QA	357,8
114	11	326,1	511,8	-185,7	326,1	423,8	-97,7	NOT QA	-97,7
115	43	151,1	385,2	-234,1	151,1	213,2	-62,1	NOT QA	-62,1
116	13	567,0	481,0	86,0	450,0	380,0	70,0	YES QA	86,0
117	25	41,2	355,4	-314,2	41,2	255,4	-214,2	NOT QA	-214,2
118	7	172,9	496,8	-323,9	172,9	440,8	-267,9	NOT QA	-267,9
119	35	3,8	369,6	-365,8	3,8	229,6	-225,8	NOT QA	-225,8
120	12	349,1	487,2	-138,1	349,1	391,2	-42,1	NOT QA	-42,1
121	23	617,9	283,3	334,6	450,0	210,0	240,0	YES QA	334,6

122	5	495,0	455,0	40,0	450,0	410,0	40,0	YES QA	40,0
123	32	738,0	286,0	452,0	450,0	180,0	270,0	YES QA	452,0
124	9	101,9	490,7	-388,8	101,9	418,7	-316,8	NOT QA	-316,8
125	29	620,2	307,1	313,1	450,0	210,0	240,0	YES QA	313,1
126	6	504,0	462,0	42,0	450,0	410,0	40,0	YES QA	42,0
127	33	222,5	337,3	-114,8	222,5	205,3	17,2	NOT QA	17,2
128	10	20,7	507,7	-487,0	20,7	427,7	-407,0	NOT QA	-407,0
129	20	213,4	316,3	-102,9	213,4	236,3	-22,9	NOT QA	-22,9
130	2	164,1	457,8	-293,6	164,1	441,8	-277,6	NOT QA	-277,6
131	37	529,3	319,2	210,1	450,0	180,0	270,0	NOT QA	270,0
132	18	127,0	559,9	-432,9	127,0	415,9	-288,9	NOT QA	-288,9
133	31	151,9	367,1	-215,2	151,9	243,1	-91,2	NOT QA	-91,2
134	15	585,0	525,0	60,0	450,0	410,0	40,0	YES QA	60,0
135	43	192,3	380,6	-188,3	192,3	208,6	-16,3	NOT QA	-16,3
136	17	50,1	560,4	-510,4	50,1	424,4	-374,4	NOT QA	-374,4
137	24	494,8	301,0	193,7	450,0	210,0	240,0	NOT QA	240,0
138	6	504,0	462,0	42,0	450,0	410,0	40,0	YES QA	42,0
139	36	152,9	357,0	-204,1	152,9	213,0	-60,1	NOT QA	-60,1
140	10	92,2	499,8	-407,6	92,2	419,8	-327,6	NOT QA	-327,6
141	40	416,4	373,7	42,7	416,4	213,7	202,7	NOT QA	202,7
142	20	630,0	560,0	70,0	450,0	410,0	40,0	YES QA	70,0
143	50	491,5	375,4	116,1	450,0	180,0	270,0	NOT QA	270,0
144	30	720,0	600,0	120,0	450,0	380,0	70,0	YES QA	120,0
145	35	574,8	336,1	238,7	450,0	210,0	240,0	NOT QA	240,0
146	10	394,8	496,1	-101,3	394,8	416,1	-21,3	NOT QA	-21,3
147	45	614,9	341,7	273,3	450,0	180,0	270,0	YES QA	273,3
148	10	540,0	460,0	80,0	450,0	380,0	70,0	YES QA	80,0
149	20	366,8	299,2	67,6	366,8	219,2	147,6	NOT QA	147,6
150	0	450,0	420,0	30,0	450,0	410,0	40,0	NOT QA	40,0
151	35	635,6	299,4	336,2	450,0	180,0	270,0	YES QA	336,2
152	0	450,0	390,0	60,0	450,0	380,0	70,0	NOT QA	70,0
153	33	743,6	309,4	434,3	450,0	210,0	240,0	YES QA	434,3
154	3	477,0	441,0	36,0	450,0	410,0	40,0	NOT QA	40,0
155	45	855,0	325,0	530,0	450,0	180,0	270,0	YES QA	530,0
156	12	31,3	522,5	-491,2	31,3	426,5	-395,2	NOT QA	-395,2
157	30	720,0	310,0	410,0	450,0	210,0	240,0	YES QA	410,0
158	0	450,0	420,0	30,0	450,0	410,0	40,0	NOT QA	40,0
159	40	810,0	310,0	500,0	450,0	180,0	270,0	YES QA	500,0
160	10	478,0	456,9	21,2	450,0	380,0	70,0	NOT QA	70,0